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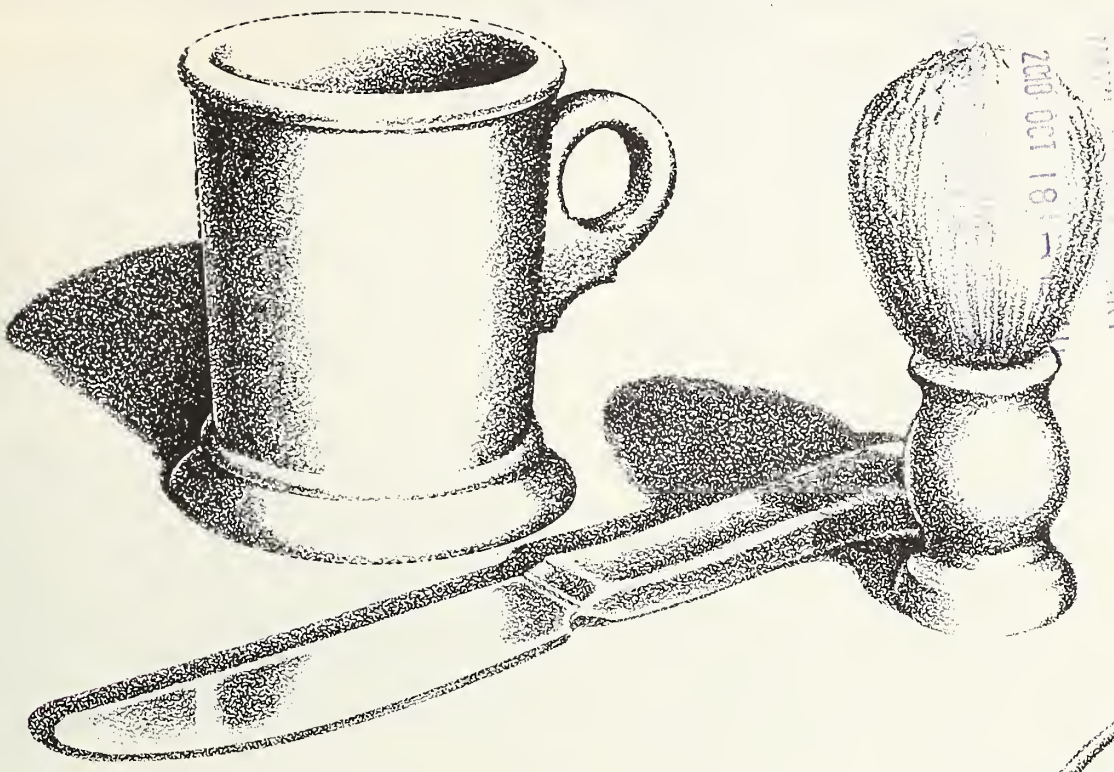

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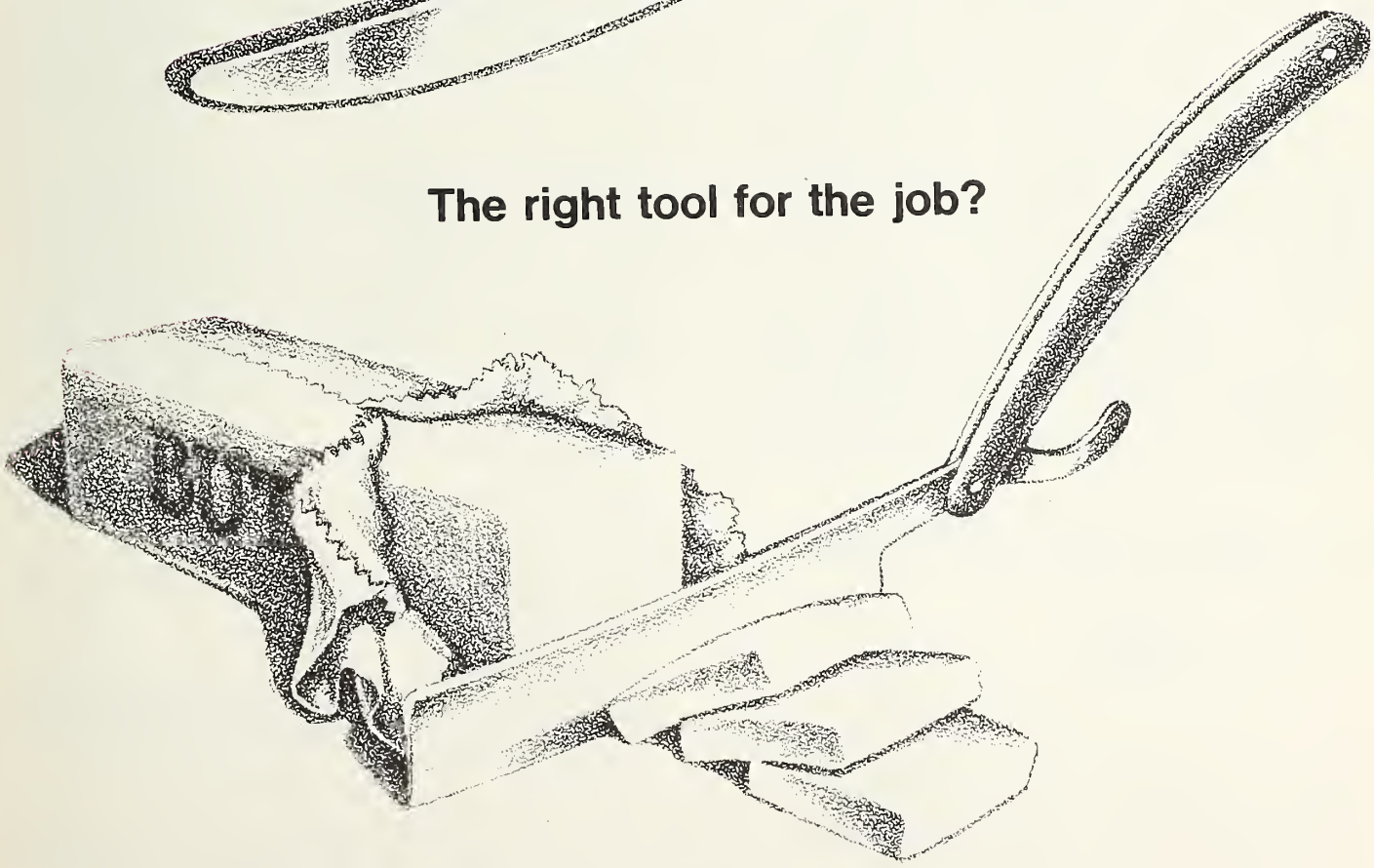

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In This Issue

A supposition underlying most research is what has been called "the mathematical assumption." Its usual application implies that social and physical changes follow a deterministic scheme controlled by behavioral rules or laws. But for the mathematical assumption to be useful, still more is required of nature: it must display simplicity, uniformity, and unity. Even though nature is known not to satisfy these requirements completely, the mathematical assumption has proven fruitful. Archimedes made it when he worked out the principles of the lever. Galileo made it when he worked out the principles of a falling body. Newton made it when he worked out the principles of planetary motion. And economists made it when they worked out the principles of prices and quantities and of income and employment.

The mathematical assumption has not gone unquestioned. One of the most convincing objections is that it stresses quantity and can lead to a neglect of quality. Sometimes the switch from qualitative contemplation to quantitative measurement is a clear gain, as when we replaced the qualitative terms of "crisis" and "panic" with quantitative measures of intensity and duration of various phases of the business cycle. At other times, the switch remains questionable, as when we substitute quantitative measures of income per capita for qualitative indications of changes in the quality of life.

A delicate balance needs to be maintained between attaining enough simplicity and oversimplifying. William of Occam preferred the simplicity of assumptions. He was a 14th century intellectual leader who distrusted systems of thought based on abstractions. A maxim attributed to him is known as Occam's Razor: The assumptions introduced to explain a thing must not be multipled beyond necessity. We might add that the assumptions must not be oversimplified beyond usefulness.

We calculate the orbit of the earth around the sun on the assumption that the orbit is independent of the gravitational forces of Jupiter, Mars, and the other planets. This simplifies the calculation and leads to satisfactory answers for most purposes. But not recognizing these other forces means that we cannot calculate whether the planetary system has long-run stability. We forecast prices and quantities on the assumption that markets are competitive. But not recognizing market imperfections means that we cannot evaluate the efficiency and equity of the economic system.

The first article in this issue demonstrates how the attribute of simplicity in the mathematical assumption can be worth the price of inaccuracy; it shows that a more accurate model is not worth the costs of its complexity. Five measures of consumer welfare drawn from the writings of J. R. Hicks are applied to a problem involving the effect on welfare of a ban on pesticide use in agriculture. The simplest and most easily calculated indexes prove to be sufficient as a basis for policy analysis—a conclusion anticipated by Hicks.

The second article is a reminder that some tasks require a sharp razor. Economic models that are too simple can obscure relevant relationships. Assuming competition to explain a monopolistic market simplifies the analysis, but obscures our view of the pricing system. J. M. Keynes compared the economist's "axiom of competition" to the geometer's "axiom of parallels" and showed that a noncompetitive assumption in economics, like non-Euclidian geometry in physics, can lead to increased knowledge. This article shows that Keynes made an additional assumption about human behavior that restored the characteristics of simplicity, uniformity, and unity and that enabled him to use the mathematical assumption to explain the monopolistic theory of interest, employment, and money.

Clark Edwards

Contents

Use of Paasche and Laspeyres Variations to Estimate Consumer Welfare Change

By Dennis C. Cory, Russell L. Gum, William E. Martin, and Marie Leigh*

Abstract

Many measurements of consumer welfare have been proposed to reflect the income equivalent of a welfare change. Measures used in policy evaluations are compensating variation, equivalent variation, Paasche variation, Laspeyres variation, and consumer's surplus. This research presents an empirical test for differences among these five welfare measures in a dynamic multimarket context. We argue that in many policy evaluations, adequate and rigorous information for decisionmaking is supplied by estimates for the easily calculated Paasche and Laspeyres variations, and consumer's surplus measures.

Keywords

Consumer welfare change, Paasche variation, Laspeyres variation, consumer's surplus, policy evaluation

Introduction

Almost all changes in agricultural policy affect consumers directly or indirectly. For example, a ban on insecticides in corn production directly affects prices and quantities of products for which corn is an input as well as prices and quantities of substitute commodities. This research compares and evaluates alternative measures of consumer welfare for this example.

In a classic series of articles appearing in the *Review of Economic Studies*, J. R. Hicks (*6*, *7*, *9*) examined the relationships among alternative measures of consumer welfare change and delineated the conditions under which a particular measure would be appropriate.[1] Hicks analyzed the theoretical foundations of compensating variation (CV), equivalent variation (EV), and consumer's surplus (CS) measures of welfare change as well as their relationship to the more readily computable measures of Paasche (PV) and Laspeyres (LV) variations.[2]

Theoretical interest in alternative measures of welfare change characterizes much of the welfare literature. Although opinions are diverse and at times adversarial, analysts agree that CV and EV constitute a conceptually valid basis for cost-benefit analysis (*14*, *15*).[3] In addition, Willig (*20*) has demonstrated that consumer's surplus can be reliably used in many applied studies as a measure of welfare change.

However, a review of this literature leaves analysts with no clear-cut procedure for estimating the consumer impacts of policy proposals. Although the convenience of using PV and LV in estimating consumer welfare change is appealing, theoretical considerations suggest that the additional analysis required for calculating appropriate CV and EV estimates is also necessary. Much confusion still exists, although 40 years ago, Hicks considered the convenience-accuracy tradeoffs and concluded:

> There is no theoretical objection to this sort of adjustment, but it is a fiddling business, fortunately not likely to be of much importance (*9*, p. 109).

He later wrote:

> . . . the distinctions we have been making will, in the vast majority of cases, be of very little importance (*7*, p. 40).

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[1] Italicized numbers in parentheses refer to the references at the end of this article.

[2] Each of these measures of consumer welfare change is defined in the following section.

[3] Some analysts maintain, however, that only CV measures satisfy the potential Pareto improvement criterion. Moreover, when post-policy quantity adjustments are impossible, analysts must use Hicks' compensating surplus measure of consumer welfare change.

Our purpose here is to test empirically, in a dynamic multimarket context, the differences among the five welfare measures—PV, LV, CV, EV, and CS. Using a multimarket econometric model, we estimate the change in consumer welfare resulting from a ban on the use of insecticides in corn production, and trace the impacts through the price and quantity changes for 11 agricultural products over the 1980-85 period. We calculate differences among these five measures of consumer welfare change by commodity, and we explore the implications for policy evaluation.

Measures of Consumer Welfare Change

The origin of the concept of consumer's surplus is generally credited to Dupuit (*4*), who in 1844, posited that a buyer can receive a surplus from a transaction. His concept was subsequently popularized by Marshall (*11*) and reinterpreted as the surplus utility a consumer derives from being able to buy a commodity at a particular price. An economic measure of this utility surplus, he argued, is given by the Depuit triangle (that is, the triangular area below the demand curve and above the price line).

Following the development of ordinal utility analysis, Hicks redefined more rigorously measures of the change in consumer welfare resulting from an actual or proposed price change. In response to an extension suggested by Henderson to his earlier analysis (*9*), Hicks defined four measures of consumer welfare change (*6*, *7*, *8*). Two of these measures, CV and EV, are relevant to the analysis presented here.[4]

Hicks defined CV as the amount of compensation, paid or received, that will leave consumers in their initial welfare position following a price change if they are free to buy any quantity of the commodity at the new price. In contrast, he defined EV as the amount of compensation, paid or received, that will leave consumers in their subsequent welfare position in the absence of a price change if they are free to buy any quantity of the commodity at the old price.

Generally, CV and EV will not be equal. In practice, only one of the two measures will be appropriate as dictated by the existing distribution of property rights and compensation criteria. The selection of one of these measures is not a matter of theoretical debate, as argued by some analysts (for example, Boadway (*1*)), as either measure constitutes a conceptually valid foundation for analyzing consumer welfare change. The selection depends on a social judgment as to whether the initial or the subsequent welfare position is taken as a basis.

Two alternative measures of consumer welfare change are LV and PV. LV is the change in income required to purchase the original quantities of all goods after prices have changed. In contrast, PV is the change in income required to purchase the subsequent set of goods when consumers face the initial price situation. LV, like CV, measures the variation required to maintain the initial welfare position. PV and EV measure the variation required to maintain the subsequent welfare position.

These changes can be expressed by the following equations:[5]

$$EV = -\sum_r X_r \Delta P_r - \frac{1}{2}\sum_{rs}\frac{\partial X_r}{\partial P_s}\Delta P_r \Delta P_s \qquad (1)$$

$$+\frac{1}{2}\sum_r X_r \Delta P_r \cdot \sum_r \frac{\partial X_r}{\partial M}\Delta P_r$$

$$CV = -\sum_r X_r \Delta P_r - \frac{1}{2}\sum_{rs}\frac{\partial X_r}{\partial P_s}\Delta P_r \Delta P_s \qquad (2)$$

$$-\frac{1}{2}\sum_r X_r \Delta P_r \cdot \sum_r \frac{\partial X_r}{\partial M}\Delta P_r$$

$$LV = -\sum_r X_r \Delta P_r \qquad (3)$$

$$PV = -\sum_r X_r \Delta P_r - \sum_{rs}\frac{\partial X_r}{\partial P_s}\Delta P_r \Delta P_s \qquad (4)$$

$$CS = \frac{LV + PV}{2} \qquad (5)$$

where:

$X_1 \ldots X_n$ are commodities,

[4] For a thorough review of the historical development of the concept of economic surplus and a discussion of the remaining two measures, compensating surplus and equivalent surplus, see (*3*).

[5] Equations (1) to (5) are from Hicks (*6*) and ignore all terms of higher order than the second.

$P_1 \ldots P_n$ are prices,

$1 \leqslant r, s \leqslant n$

and:

$$M = \sum_{1}^{n} P_r X_r$$

and a negative sign indicates a loss of welfare.

If $\sum_r (\partial X_r / \partial M) \Delta P_r$ is negative for a welfare increase, or is positive for a welfare decrease, then:

$$LV < CV < CS < EV < PV \qquad (6)$$

Hicks (*6*) argues that the conditions where equation (6) does not hold are not likely to occur in any realistic policy evaluation. Therefore, for most empirical work, it can be considered that LV and PV are the upper and lower bounds for all the relevant measures of consumer welfare change.

In addition, the midpoint between LV and CV, which equals CS, is an upper bound for CV and a lower bound for EV. Inasmuch as LV, CS, and PV are far easier to calculate than the theoretically more defensible CV and EV, the empirical question raised by Hicks is whether these bounds are sufficiently close approximations to serve as a basis for policy analysis.

Additional Theoretical Considerations

The estimation of consumer's surplus as the average of PV and LV is based on the assumption of linear adjustment paths, thus avoiding the indeterminacy problems created by path dependency (*2*, *17*). Furthermore, an estimate of the potential change in aggregate welfare is implied by changes in market prices and quantities as a result of the ban on insecticides.[6] Interpersonal utility comparisons are needed to evaluate the distribution of the aggregate potential gain among households, Failing that, a value judgment must be made that society is willing to make certain groups less well off to increase the welfare of others. In addition, we do not estimate related changes, such as capital gains and losses to landowners or health implications for applicators. For these reasons, the estimates of welfare change presented here are but one input into a comprehensive policy evaluation. Our purpose is to examine the convenience-accuracy tradeoff described by Hicks.

Finally, we used the Taylor series approximations for CV and EV estimates developed by Hicks (6) and elaborated upon by McKenzie and Pearce (equations (1-4) and (6)). Willig (21) has expressed reservations about these estimates, as their accuracy depends on the remainder term in the Taylor series approximation. Our position, like that advocated by McKenzie (*12*), is that by incorporating additional terms in the Taylor expansion, analysts can make estimates for CV and EV that are as accurate as necessary for evaluating policy. The additional terms were not necessary in our application because the remainder is zero, given the structure of the empirical model we used.

Estimates for Alternative Measures of Consumer Welfare Change

Pimental and Shoemaker (*16*) have estimated that implementing a ban on the use of insecticides in corn production would result in a 3-percent reduction in annual U.S. corn yield. This loss in production would have consequences in prices and quantities throughout the agricultural sector. Products directly affected by such a change would include pork, beef, veal, chicken, turkey, eggs, ice cream, evaporated milk, fluid milk, cheese, and butter. This food group constitutes approximately 50 percent of all food consumed at home and accounts for 10 percent of total consumer expenditures (*19*, p. 68).

We estimated the five measures of consumer welfare change for the 1980-85 period in each of these 11 markets. These markets provide a comparatively comprehensive accounting, although a complete general equilibrium analysis would require extending the evaluation to remaining food and nonfood (for example, housing, apparel, transportation, health, and recreation) groups.

The Econometric Model

We used the Cross Commodity Forecasting System (CCFS), a multimarket econometric model of the 11 commodities of interest plus feed grains, soybeans, and wheat to assess the impact on consumers of a ban on insecticides in corn production. The CCFS was developed by commodity specialists in USDA to "reflect, in an annual aggregate sense, the under-

[6] Winch presents a comprehensive analysis of interpreting alternative measures of welfare change in the absence of complete compensation, and he presents the case for preferring CS over either CV or EV in situations where desired compensation criteria will not be met (*22*).

lying direct and cross economic effects of the crop and livestock sector" (*18*, p. 1). The model includes 158 endogenous and 136 exogenous variables, with each commodity submodel containing retail, farm, and investment demand equations, supply equations for live animals and carcasses, product stocks, conversion relationships, and supply and demand identities.

Solution values generated by the CCFS, as well as the structural relationships within each commodity submodel, were used to provide the information necessary to calculate measures of consumer welfare change.[7] We derived these welfare measures by comparing results *with* the ban to those *without* the ban for a standard set of exogenous variables.

Estimation Results

Table 1 summarizes the projected total loss in Marshallian consumer's surplus experienced by the Nation's consumers.[8] Losses, by commodity, range from $7 million for ice cream consumption to approximately $29 billion for beef consumption. Losses were $500 million in the first year and increased to $16 billion in the last year recorded. For all commodities, losses total approximately $50 billion for the 6-year period.

Table 2 gives estimates, by year, for all five consumer welfare measures and shows the change in CS as a percentage of disposable income and the deviation of PV and LV from CS. PV and LV bound the range of values that EV, CV, and the change in CS can assume.

Estimates of the total loss in consumer welfare from 1980 through 1985 range from $49 billion to almost $51 billion. Total change in CS is 0.39 percent of total disposable income. PV and LV differ from this change by 1.7 percent. That is, all five estimates for the cumulative impact on consumer welfare lie within a $1.67 billion range that corresponds to the CS estimate, plus or minus 1.7 percent.

We also estimated the five welfare measures by commodity, over the 6-year study period. Again, the variations are small. Except for veal, estimates lie within a small range of the CS value, varying from as little as 0.1 percent for eggs to 2.4 percent for chicken. Variability among estimates of consumer impacts in the market for veal is larger than for other commodities because of the sensitivity of veal production to price changes among substitute commodities. Because of price increases in substitutes, veal demand and production increase in the short run. Then, as its own price increases, substitution shifts back toward beef and turkey, virtually eliminating veal production.

By 1985, production of livestock commodities, except veal, will become stabilized. A new equilibrium level appears to be reached. A significant change in veal production might occur after 1985; however, because of its relative unimportance as a livestock product, the effect on welfare measures would be small.

Conclusions

The results of this empirical analysis demonstrate that the posited 3-percent decrease in corn yields would have a negative impact on consumers. Expressed as a percentage of disposable income, losses in CS averaged 0.39 percent over the 6-year period. However, this welfare cost, coupled with estimates of the impact on agricultural producers, would have to be weighed against the potential health and environmental benefits of discontinuing the use of insecticides in corn production before a judgment on the overall merit of banning the use of insecticides in corn production could be made. In addition, a complete policy analysis would require further verification of the estimate of yield reduction.

The estimated differences between alternative measures of consumer welfare change are small. The PV and LV provide a narrow range in which the value of the welfare change will lie. For the commodities analyzed, PV and LV differ from CS by about 1 percent in most cases, with the deviation between these measures increasing over time from 0.4 percent in the first year to 2.2 percent in the last, and averaging 1.7 percent over the 6-year period. Of course, the differences between CS and CV or EV are even smaller. Our results are consistent with Willig's contention (*20*) that in most cases, CV and EV will be within 2 percent of CS.[9]

Implications for Applied Research

Although the empirical results of this investigation depend on the CCFS model and Pimental's estimate of yield impacts,

[7] See (*18*) for additional documentation of the CCFS.

[8] In a vertically structured sector of the economy like agriculture, CS measures in final output markets have welfare significance for associated input markets as well. For a discussion, see (*10*).

[9] The accord among these measures can be expected whenever: (1) the change in consumer surplus is less than 5 percent of consumer income, and (2) income elasticities of demand lie between ± 1 (*20*).

For most policy evaluations, this simple two-step procedure will provide information which is detailed and rigorous enough for decisionmaking.

Table 1—Projected total losses in Marshallian consumer's surplus due to decreased corn yields, 1980-85

Commodity	1980	1981	1982	1983	1984	1985	Total by commodity
	Billion dollars						
Pork	0.2577	0.5810	1.4250	2.5036	2.7346	2.6700	10.1719
Beef	.0401	.1052	1.8146	6.6052	9.9773	10.2400	28.7824
Veal	.0020	.0092	.0987	.2856	.2482	.0617	.7054
Chicken	.1057	.2328	.5831	1.2034	1.5623	1.6467	5.3340
Turkey	[1](.0002)	.0158	.1539	.3434	.4560	.4724	1.4413
Eggs	.0651	.1453	.3315	.6625	.8685	.9602	3.0331
Ice cream	.0013	.0013	.0013	.0012	.0011	.0011	.0073
Evaporated milk	.0013	.0028	.0024	.0018	.0015	.0013	.0111
Fluid milk	.0282	.0563	.0534	.0512	.0236	.0234	.2361
Cheese	.0147	.0293	.0255	.0200	.0143	.0122	.1160
Butter	.0034	.0076	.0064	.0046	.0042	.0035	.0297
Total	.5193	1.1866	4.4958	11.6825	15.8916	16.0925	49.8683

[1] Gain in welfare, for 1980 only.

Table 2—Alternative estimates of total consumer welfare losses, 1980-85

Year	Population	Total disposable income	Paasche variation (PV)	Equivalent variation (EV)	Consumer's surplus (CS)	Compensating variation (CV)	Laspeyres variation (LV)	Percentage deviation of PV and LV from CS	CS as a percentage of disposable income
	Millions	*Billion dollars*						*Percent*	
1980	221.9	1,725	0.5177	0.5191	0.5192	0.5193	0.5207	0.3	0.03
1981	223.0	1,875	1.1804	1.1861	1.1865	1.1868	1.1925	.5	.06
1982	225.0	2,033	4.4677	4.4909	4.4958	4.5007	4.5240	.6	.22
1983	226.7	2,205	11.5331	11.6505	11.6824	11.7143	11.8317	1.3	.53
1984	228.4	2,388	15.5895	15.8357	15.8917	15.9477	16.1940	1.9	.67
1985	230.1	2,592	15.7438	16.0378	16.0915	16.1452	16.4391	2.2	.62
Total	1,355.1	12,818	49.0322	49.7201	49.8671	50.0140	50.7020	1.7	.39

they do suggest that, regardless of the specific models used for estimation purposes, adjusting CS estimates to obtain the theoretically preferable measures of CV and EV may indeed be a "fiddling business."

These results generally suggest a pragmatic procedure for analysts to follow in applied policy evaluations. First, the analysts should calculate the PV and LV measures of welfare change. Next, assuming direct linear paths of price adjustment, as Burns (2) suggests, they can use the midpoint of this range as a practical and reasonable estimate for the change in CS.

For most policy evaluations, this simple two-step procedure will provide information which is detailed and rigorous enough for decisionmaking.

References

(1) Boadway, R.W. "The Welfare Foundations of Cost-Benefit Analysis," *Economic Journal*, Vol. 84, 1974, pp. 926-39.

(2) Burns, Michael E. "A Note on the Concept and Measure of Consumer Surplus," *American Economic Review*, Vol. 63, 1973, pp. 335-44.

(3) Currie, John Martin, John A. Murphy, and Andrew Schmitz. "The Concept of Economic Surplus and Its Use in Economic Analysis," *Economic Journal*, Vol. 81, 1971, pp. 741-99.

(4) Dupuit, J. "On the Measurement of the Utility of Public Works," *Annales des Ponts et Chaussées*, Vol. 8, 1844. Translation reprinted in D. Munby, *Transport*, 1968.

(5) Henderson, A. "Consumer's Surplus and the Compensating Variation," *Review of Economic Studies*, Vol. 8, 1941, pp. 117-21.
(6) Hicks, J.R. "Consumer's Surplus and Index Numbers," *Review of Economic Studies*, Vol. 9, 1942, pp. 126-37.
(7) _____. "The Four Consumer's Surpluses," *Review of Economic Studies*, Vol. 11, 1943, pp. 31-41.
(8) _____. "The Generalized Theory of Consumer's Surplus," *Review of Economic Studies*, Vol. 13, 1945, pp. 68-74.
(9) _____. "The Rehabilitation of Consumer's Surplus," *Review of Economic Studies*, Vol. 8, 1941, pp. 108-16.
(10) Just, Richard E., and Darrell L. Hueth. "Welfare Measures in a Multimarket Framework," *American Economic Review*, Vol. 69, 1979, pp. 947-50.
(11) Marshall, Alfred. *Principles of Economics*. London, 1930.
(12) McKenzie, George W. "Consumer's Surplus Without Apology: Comment," *American Economic Review*, Vol. 69. 1979, pp. 465-68.
(13) _____, and I.F. Pearce, "Exact Measures of Welfare and the Cost of Living," *Review of Economic Studies*, Vol. 43, 1976, pp. 465-68.
(14) Meade, J.E. "Review of *Cost-Benefit Analysis* by E.J. Mishan," *Economic Journal*, Vol. 82, 1972, pp. 244-46.
(15) Mishan, E.J. "The Use of Compensating and Equivalent Variations in Cost-Benefit Analysis," *Economica*, Vol. 43, 1976, pp. 185-97.
(16) Pimental, David, and Christine Shoemaker. "An Economic and Land Use Model for Reducing Insecticides on Cotton and Corn," *Environmental Entomology*, Vol. 3, 1974, pp. 10-19.
(17) Silberberg, Eugene. "Duality and the Many Consumer's Surplusses," *American Economic Review*, Vol. 62, 1972, pp. 942-52.
(18) Teigen, Lloyd D., and Abner W. Womack. *An Econometric Model of the Livestock and Feed Sector*. U.S. Dept. Agr., Econ. Stat. Coop. Serv., 1979.
(19) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service. *Food Consumption, Prices, and Expenditure*. AER-138. 1978.
(20) Willig, R. "Consumer's Surplus Without Apology," *American Economic Review*, Vol. 66, 1976, pp. 589-97.
(21) _____. "Consumer's Surplus Without Apology: Reply," *American Economic Review*, Vol. 69, 1979, pp. 469-74.
(22) Winch, David M. "Consumer's Surplus and the Compensation Principle," *American Economic Review*, Vol. 55, 1965, pp. 395-42.

In Earlier Issues

The best tool of management is an adequate record system. But there is an almost universal absence of suitable, simplified records which furnish the basis for sound decisions. . . . Most of the systems so far proposed have proved so complicated as to defeat the purpose for which they were intended.

M. Truman Fossum
Vol. 6, No. 1, Jan. 1954, p. 21

Keynes' Monopolistic Theory of Employment, Interest, and Money

By Clark Edwards*

Abstract

Competition is usually assumed as the general case in applications of classical and neoclassical economic theory. Monopoly is treated as a special case. Several leading economists during the thirties sought to develop a general theory of monopoly within which competition might be treated as a special case; among these was John Maynard Keynes. This article develops the implications of Keynes' monopolistic assumptions for inflation and unemployment. Reconciliations of Keynesian macroeconomics with neoclassical aggregative theory that are based on the assumption that both models are competitive are misleading because they fail to capture the role of monopoly in the Keynesian model.

Keywords

Economic theory, monopoly, inflation, unemployment

Introduction

Classical economic theorists were likened by John Maynard Keynes, in his *General Theory of Employment, Interest, and Money* (7, p. 16),[1] to "Euclidean geometers in a non-Euclidean world." Just as non-Euclidean geometers built new and useful logical systems by denying the fifth postulate of Euclid—the so-called "axiom of parallels"—so, implied Keynes, can economists build a new and useful system of economic thought by denying certain classical economic postulates. "It is, then," claimed Keynes, "the assumption of equality between the demand price of output as a whole and its supply price which is to be regarded as the classical theory's 'axiom of parallels'" (7, p. 21). Keynes was saying: Let us generalize by assuming that Marshallian (8) supply and demand curves *do not* necessarily intersect in equilibrium, and then let us see if the resulting theory better explains economic behavior than does a theory which assumes such curves *do* intersect. Keynes found the experiment in monopoly theory successful and concluded that "we are thus led to a more general theory, which includes the classical theory with which we are familiar as a special case" (7, p. vii).

The classical economic postulate to which Keynes objected implied competitive markets. It is only in competitive markets that Marshallian supply and demand curves necessarily intersect in equilibrium. The classical theory treated competition as the general case, and it recognized and discussed monopoly as a special case. Keynes was among those who sought to change this point of view and to consider the competitive classical model as a special case of a general, monopolistic model.

The idea of replacing the classical extremes of competition and monopoly with something more realistic had been in the air for several years before Keynes published his *General Theory*. Joan Robinson, in her foreword to *Imperfect Competition*, identified an article by Piero Sraffa in the *Economic Journal* of December 1926 as "the fount from which my work flows" (10, p. v). She attributed considerable importance to the prior contributions of R. F. Kahn, Roy F. Harrod, and others. "The notion of a supply curve has always been associated with the notion of perfect competition," Robinson reminds us, "but if we are to study conditions in which competition is not perfect the orthodox conception of a supply curve must be reconsidered" (10, pp. 85-86). Robinson concludes: "It has been the purpose of the foregoing argument to show that . . . it is more proper to set out the analysis of monopoly, treating perfect competition as a special case" (10, p. 307).

Chamberlin tells us in his *Monopolistic Competition* that his search for a hybrid theory of monopoly and competition grew out of his analysis of railway rates in 1921 (2, p. 293). He agreed with Keynes and Robinson that "if either [monopoly or competition] is to be omitted from the picture, the ubiquitous monopoly has much more in its favor" (2, p. 11). Chamberlin underscored Keynes' point that "supply and demand are not equated in monopoly equilibrium" (2, p. 13), and he carefully distinguished between equilibrium prices,

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[1] Italicized numbers in parentheses refer to items in the references at the end of this article.

which occur under both monopoly and competition, and the equality of supply and demand, which occurs only under competitive equilibrium. He used the terms "special" and "general" in the same context that Keynes and Robinson had used them; that is, equality between demand and supply is "merely a special case" of price equilibrium, and the result of the hybrid model is "very generally equilibrium prices" (2, p. 15).

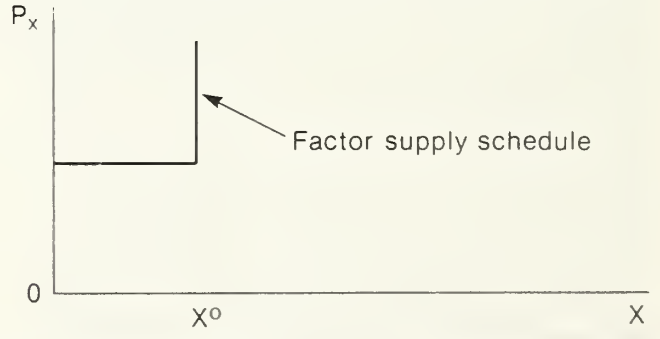
Chamberlin differed from Keynes and Robinson, who viewed competition as a special case of general monopoly. Instead, he viewed monopolistic competition as the general case of which pure competition and pure monopoly were each special cases. But he fully agreed that the classical view—that competition was the general, and monopoly, the special case—was unacceptable. All three economists sought a system for which supply and demand curves do not necessarily intersect in equilibrium and, therefore, for which the supply price is not equal to the demand price.

Today we consider Robinson's and Chamberlin's books as two important landmarks on the road toward our general understanding of monopolistic market structure. We do not usually recognize Keynes' *General Theory*, published 3 years after the books by Robinson and Chamberlin and 10 years after the article by Sraffa, as another landmark on that journey. Keynes said of his own work that, if the classical postulate of competition holds, "there is no obstacle to full employment. . . . If, however, this is not the true law . . . there is a vitally important chapter in economic theory which remains to be written and without which all discussions concerning the volume of aggregate employment are futile" (7, p. 26). In his own preface, he recognized an indebtedness to Kahn, Harrod, Robinson, and others who had contributed to the theory of monopolistic markets.

My purpose here is to set forth a simplified version of Keynes' monopolistic theory. My aim is not so high as to explain the difficulties this country has been having in recent years with inflation, unemployment, sluggish growth, and a weakening dollar. Rather, it is to focus on one aspect of the models we now use to explain these problems and to suggest that the equations in these models, which reflect either competitive price determination or which represent a Phillips curve, might be replaced with equations which reflect, instead, the monopolistic price determination suggested by Keynes.

Keynes began in chapter 3 by redefining four terms: aggregate demand function, aggregate supply function, aggregate demand price, and aggregate supply price. He continued to use the classical jargon, but with different meanings. The aggregate demand price became the proceeds which entrepreneurs expected to receive from the sale of the output associated with a given level of employment. The aggregate supply price for the output became the income (factor cost plus profit) associated with that level of employment. Equilibrium occurs when aggregate demand price equals aggregate supply price—that is, when gross national product equals gross national income. This equilibrium defined what Keynes called "effective demand" (7, pp. 25, 304). His redefinitions directed attention away from Marshallian demand and supply curves. Whereas Marshall spoke of a schedule of quantities that would clear the market for alternative prices, Keynes spoke of levels of employment that would be consistent with alternative levels of expenditure. That Keynes used the old economic jargon to denote his new concepts resulted in considerable confusion among his readers. Thus, when Keynes spoke of "the intersection of the aggregate demand function with the aggregate supply function" (7, p. 30), it was his own redefined concepts for which supply equalled demand—not the Marshallian concepts. Moreover, by his denial of the economists' "axiom of parallels," he assumed at the outset that the Marshallian supply and demand curves did not necessarily intersect in equilibrium.

The Marshallian schedules of quantities that will clear the market at alternative prices were suppressed in the Keynesian reformulation. They were no longer needed because they were generally no longer expected to intersect in equilibrium. Keynes explicitly alluded to the Marshallian supply function in his formulation of the factor market; he said that labor is in "perfectly elastic supply so long as there is unemployment, and perfectly inelastic supply so soon as full employment is reached" (7, p. 295). We can diagram this reformulation of Marshallian factor supply as follows, with X as an index of employment and P_x as an index of the nominal wage:

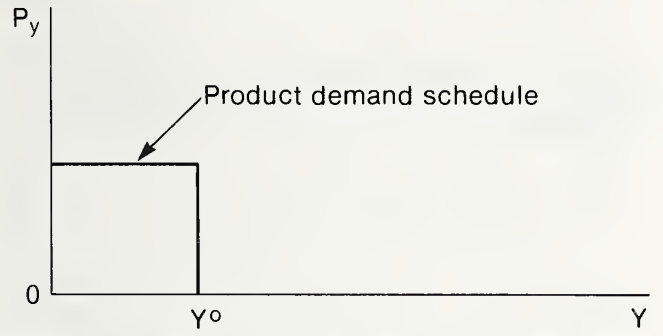


The classical theory treated competition as the general case, and it recognized and discussed monopoly as a special case. Keynes was among those who sought to change this point of view and to consider the competitive classical model as a special case of a general, monopolistic model.

The perfectly elastic segment of this factor supply function reflects Keynes' idea of rigid wages. "Labor is not prepared to work for a lower money-wage" (7, p. 8). The segment became, in Keynes' monopolistic theory, the battle line between bilateral monopolists; management was on one side and labor unions on the other.

Today we interpret Keynes' aggregate demand function as a schedule of expenditures that vary with income. His product supply curve in this reformulation is reduced to the tautological "income varies with income," and it is plotted on the Keynesian cross diagram as a 45° line. A change in expenditure may reflect a change in price or in quantity or in both.

In addition to assuming a rigid wage so long as there is unemployment, Keynes added that an increase in demand "will have no effect whatever on prices" (7, p. 295). The implied Marshallian product demand schedule was, apparently, perfectly elastic up to the level of expenditures warranted by the propensity to consume out of income. The curve became perfectly inelastic at that point. We can diagram this reformulation of Marshallian product demand as follows, with Y as an index of aggregate real product and P_y as an index of the general price level:



This formulation set up the general price level as a battle line between bilateral monopolists; consumers were on one side and business on the other. Modigliani has shown that we need not describe the product market in this way to achieve the Keynesian result of unemployment in equilibrium, provided that we describe the factor market as one of rigid wages. By the symmetry of the problem, we can assume rigid prices and flexible wages, instead of rigid wages and flexible prices, and achieve a comparable result. But we cannot achieve Keynes' results by assuming flexible wages and flexible prices because that is tantamount to assuming that the "axiom of parallels" holds. Keynes explicitly and repeatedly described the factor market as one of rigid wages, and he implied that the product market can be described as one of rigid prices. However, he did so only as an interim step in understanding pressures on wages and prices. Keynes was interested in explaining changes in prices and wages both during periods of full employment and of unemployment.

A Model

A model may help to clarify the implications of Keynes' monopolistic theory. Unlike Keynes' own version, this simplified version of his model makes the Marshallian supply and demand curves explicit, and the Keynesian aggregate supply and demand curves implicit; this facilitates a comparison of the Keynesian model with the classical model. The model developed here excludes many of the variables important in Keynesian analysis, such as consumption, investment, and the money supply; it includes the fewest number of variables required for focusing on the monopolistic structure in the product and factor markets. Modigliani has shown that such a simplification is sufficient. He found that the "propensities to save and invest are not a part of the mechanism determining employment" (9, p. 67). He also discovered that involuntary unemployment is "not [due] to the Keynesian liquidity preference. . . . This result is due entirely to the assumption of 'rigid wages' " (9, p. 65).

Keynes assumed, in agreement with the classical theorists, that maximization of profits (π) is the correct objective for the producing sector (7, p. 23):

$$\pi = P_y Y - P_x X \qquad (1)$$

where ($P_y Y$) is the demand price and ($\pi + P_x X$) is the supply price. This formulation recognizes a single product (Y), which may be thought of as real gross national product. There is a single factor (X), which may be taken as labor. Other factors, such as land and capital, are suppressed. The ensuing discussion will be much simpler if one also regards normal profits as suppressed and lets π represent profits in excess of those required to keep firms in business.

In what follows, I maximize the above profit function subject to constraints and examine the equilibrium conditions. This procedure raises a problem of interpretation. If we consider that the aggregate profit level is to be maximized, we imply a centrally planned economy. If we consider instead that

profits are maximized for each firm, we have an aggregation problem.

We can tentatively take the general price level (P_y) and the nominal wage (P_x) as given, as Keynes does (7, p. 295). This simplifies the aggregation problem because firm cost and revenue curves are additive under this assumption. Keynes relaxed this assumption soon after imposing it (7, p. 296) and inquired into mechanisms which change the nominal wage level and the general price level. I will examine Keynes' view of those mechanisms in subsequent sections. But first, I make Keynes' simplifying assumption because it eliminates the aggregation problem and allows us to interpret the resulting equations as general equilibrium conditions.

The quantities that will clear the product and factor markets at these rigid prices and wages are limited. The level of real output (Y) is less than or equal to the maximum level allowed (Y^0) by the aggregate demand function including autonomous and induced demand:

$$Y \leqslant Y^0 \tag{2}$$

The upper bound on the level of real output that will clear the market corresponds to the point at which the Marshallian product demand function becomes perfectly inelastic. The level varies, for example, with a change in government purchases of goods and services. We take this bound as (temporarily) fixed.

The level of employment (X) is less than or equal to full employment of the available labor force (X^0):

$$X \leqslant X^0 \tag{3}$$

The upper bound on the level of employment corresponds to the point at which the Marshallian factor supply function becomes perfectly inelastic.

The objective is maximized subject to the constraint of a production function. Keynes called the aggregate production function an employment function (7, pp. 25, 280). This change in terminology indicates his intention of using the function differently than it was used in the classical formulation. The employment function is:

$$Y = f(X) \tag{4}$$

This system of four equations can be represented as a Lagrangian function:

$$L = P_y Y - P_x X + \lambda_1(Y^0 - Y) + \lambda_2(X^0 - X) + \lambda_3(f(X) - Y) \tag{5}$$

The value of L is maximized with respect to output (Y) and labor (X) and minimized with respect to the Lagrangian multipliers (λ's), with the understanding that X, Y, and the λ's are non-negative. Necessary conditions for the solution to the problem are as follows:

$$\frac{\partial L}{\partial Y} = P_y - \lambda_1 - \lambda_3 \leqslant 0 \qquad \frac{\partial L}{\partial Y} Y = 0 \qquad Y \geqslant 0 \tag{6}$$

$$\frac{\partial L}{\partial X} = -P_x - \lambda_2 + \lambda_3 \frac{dY}{dX} \leqslant 0 \qquad \frac{\partial L}{\partial X} X = 0 \qquad X \geqslant 0 \tag{7}$$

$$\frac{\partial L}{\partial \lambda_1} = Y^0 - Y \geqslant 0 \qquad \frac{\partial L}{\partial \lambda_1} \lambda_1 = 0 \qquad \lambda_1 \geqslant 0 \tag{8}$$

$$\frac{\partial L}{\partial \lambda_2} = X^0 - X \geqslant 0 \qquad \frac{\partial L}{\partial \lambda_2} \lambda_2 = 0 \qquad \lambda_2 \geqslant 0 \tag{9}$$

$$\frac{\partial L}{\partial \lambda_3} = f(X) - Y = 0 \qquad \lambda_3 > 0 \tag{10}$$

The middle column above insures that, if a variable is positive, the corresponding derivative in the left column equals zero and that, if the derivative is nonzero, the corresponding variable in the right column is zero. We are interested in the case for which output is positive ($Y > 0$). It follows from equation (6) that $\partial L/\partial Y = 0$ and, therefore:

$$\lambda_3 = P_y - \lambda_1 \tag{11}$$

For a positive level of employment, $X > 0$, it follows from equations (7) and (11) that the marginal condition for equilibrium is:

$$(P_y - \lambda_1) \frac{dY}{dX} = (P_x + \lambda_2) \tag{12}$$

Keynes said that his "more general theory . . . includes the classical theory . . . as a special case" (7, p. vii). From the marginal condition, equation (12), we can understand what Keynes meant. When either λ_1 or λ_2 is greater than

zero, Marshallian demand and supply curves do not intersect and monopoly is implied; when both λ_1 and λ_2 are zero, the Marshallian curves intersect and competitive equilibrium conditions obtain:

$$P_y \frac{dY}{dX} = P_x \tag{13}$$

This is exactly what, 3 years earlier, Joan Robinson had said was the preferable approach—it reversed the order imposed by the classical approach of starting with a competitive model and including monopoly as a special case.

Keynes thought that the Lagrangian multipliers of our version of his model (λ_1 and λ_2) would vanish only under government intervention. He said, "if our central controls succeed in establishing an aggregate volume of output corresponding to full employment as nearly as is practicable, the classical theory comes into its own again" (*7*, p. 378). The point of the general model is that, given its assumption of rigid prices or rigid wages through a limited range of output or employment, the Marshallian supply and demand curves need not intersect in equilibrium except as a special case. The classical economists' counterpart to the "axiom of parallels" was "thrown over" (*7*, p. 16) and a "vitally important chapter of economic theory" (*7*, p. 26) remained to be written.

Keynes showed that unemployment can exist in equilibrium, and he focused on monetary and fiscal policies to move an equilibrium with unemployment toward one of full employment. Such a policy in our simplified version of the model might be reflected by extending Y^0 to a sufficiently high level that $X = X^0$ in equilibrium. Keynes' policies were intended to reach this goal by forcing λ_1 and/or λ_2 toward zero. Harrod (*6*) addressed this policy issue when he expanded the Keynesian model to include the effect of capital accumulation on the capacity to produce. Harrod said that capital accumulation, momentarily setting aside consideration of the supply of labor, determines the warranted rate of growth. However, labor force availability determines the natural rate of growth. Harrod was concerned that Keynes and his followers emphasized policies which focus on the natural rate while overlooking the warranted rate. Some of Harrod's followers have concentrated on the warranted rate and overlooked constraints on growth imposed by the natural rate. Robinson said later of such models that they assume workers will come in from the woods to work when we need them and go back to eat acorns when we don't. Keynes' monopolistic theory, as extended by Harrod, allows the actual rate of growth in dynamic equilibrium to differ from either the warranted or the natural rate. When this situation occurs, Harrod suggested that policies are needed to intervene and move the economy toward what he called the proper rate of growth.

The special case of perfect competition also results when the Lagrangian multipliers, λ_1 and λ_2, are set equal to zero. To warrant that, we need only assume that demand is less than the maximum, $Y < Y^0$ (see equation (8)), and employment is less than full, $X < X^0$ (see equation (9)). In this special case it follows that average revenue equals marginal revenue, which equals marginal cost, which equals average cost, and the perfectly competitive equilibrium conditions hold (see equation (13)). The Marshallian supply and demand curves meet for this special case. Keynes failed to state that unemployment can exist in a competitive situation. Robinson had anticipated such unemployment when she said, "there is no natural tendency even under competition to maintain full employment, which depends upon the levels of saving and investment" (*10*, p. 310). Modigliani (*9*) also found unemployment in this situation for which wages are rigid but competitive equilibrium is attained.

Unemployment

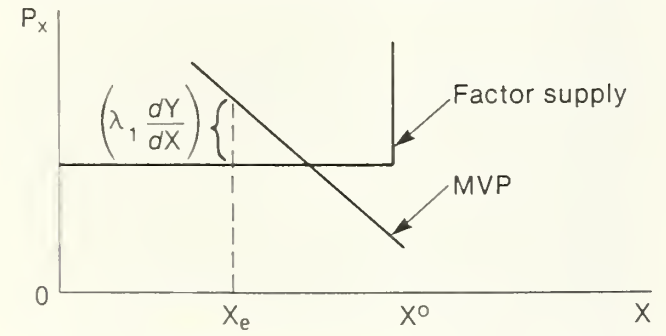
Keynes emphasized the problem of unemployment rather than inflation because that was the difficulty in Western economies when he wrote. In the simple version of his model presented here, the problem of unemployment can be described and explained from either of two points of view: insufficient aggregate product demand or excess aggregate factor supply. The two explanations are symmetrical and equivalent. Additionally, unemployment can be explained in terms of factor market concepts or product market concepts. Once again, the two explanations are equivalent. Let us consider the factor market first.

The Factor Market

If there is unemployment so that $X < X^0$, then equation (9) requires that $\lambda_2 = 0$. This is an excess of factor supply. If we set $\lambda_1 > 0$, so that Marshallian equilibrium does not occur, then it follows from equation (8) that $Y = Y^0$ and that real consumption reaches the limit allowed by the propensity to consume. There may be insufficient aggregate demand. If output increases to absorb the idle labor when aggregate demand is at its limit, the added output will not clear the market and there will be disequilibrium. The equilibrium condition in the factor market, with $\lambda_2 = 0$ and $\lambda_1 > 0$, can be stated:

$$P_y \frac{dY}{dX} = P_x + \lambda_1 \frac{dY}{dX} \qquad (14)$$

This rearranges the terms of equation (12), with $\lambda_2 = 0$. The expression on the left side is often called the marginal value product or the marginal revenue product. It can be interpreted as the Marshallian demand curve for labor if the market is competitive. The supply curve for labor is the perfectly elastic segment of labor supply for which the wage equals P_x. However, equilibrium is not at the intersection of supply and demand so long as $\lambda_1 > 0$ and Y is at its upper limit, Y^0. The marginal condition (equation (14)) indicates that the Marshallian supply and demand curves do not intersect in the factor market when insufficient aggregate demand is accompanied by unemployment. Marginal value product exceeds average factor cost by the quantity $(\lambda_1(dY/dX))$. The unemployment situation in the factor market may be diagrammed as follows:



The factor market reflects a bilateral monopoly between management and labor. That there is no unique solution to a duopoly, oligopoly, or bilateral monopoly problem had long been known. Economic theory has a history of concocting scenarios which will help specify possible solutions. Cournot (*3*) assumed that each duopolist considers that the output of the rival firm is given and then adjusts to maximize profits. Bertrand (*1*) assumed instead that each duopolist considers the price of the rival firm as given. Edgeworth (*4*) assumed that each rival would embark upon an endless series of price undercutting and price hiking. Chamberlin (*2*) assumed the existence of many firms with slightly differentiated products. Sweezy (*11*) assumed a kinked demand curve based on fear of retaliation. Von Neuman and Morgenstern (*12*) assumed each manager followed a minimax strategy. And a host of others have suggested price leadership, collusion, and other strategies to overcome the indeterminancy. As Robinson had said, there will be a different solution on each different assumption (*10*, p. 87).

Keynes found a different scenario which also avoided the crisis of indeterminacy. Labor, if it had the power, would like to force up wages by the quantity $(\lambda_1(dY/dX))$. Management, if it had the power, would like to hold wages down—even to a lower level than current wage if there is an upward-sloping Marshallian supply function lurking somewhere below the perfectly elastic segment shown by the diagram.

Keynes assumed that "labor is not prepared to work for a lower money-wage and that a reduction in the existing level of money-wages would lead, through strikes or otherwise, to a withdrawal from the labor market of labor which is now employed" (*7*, p. 8). He admitted that sometimes wages fell during slack periods (*7*, pp. 9-10). But his preferred scenario was that labor unions generally had sufficient monopoly power to prevent a wage reduction during periods of unemployment. Were recovery to begin and the market to expand, Keynes assumed "more labor than is at present employed is usually available at the existing money-wage" (*7*, p. 10). However, he recognized a situation not shown in the diagram—that labor might hold out for a higher wage should the market expand even with unemployment and no inflation. "The wage unit may tend to rise before full employment has been reached. . . . there is naturally for all groups (of workers) a pressure in this direction, which entrepreneurs will be more ready to meet when they are doing better business" (*7*, p. 301). He expected labor unions sometimes to have the upper hand in the bilateral monopoly battle over wages when the economy began to do better, and he expected management sometimes to have the upper hand when the economy began to do worse; in general, however, Keynes' scenario called for a stand-off. Wages were expected to continue around current levels. This was what J. K. Galbraith (*5*) would later describe as countervailing power.

The Product Market

A monopoly element in the factor market implies that Marshallian supply and demand curves do not intersect in the product market. Consider, as before, that there is unemployment ($X < X^0$) so that $\lambda_2 = 0$ (equation (9)) and also that $\lambda_1 > 0$ so that $Y = Y^0$ (equation (8)). The marginal condition in the product market when there is insufficient

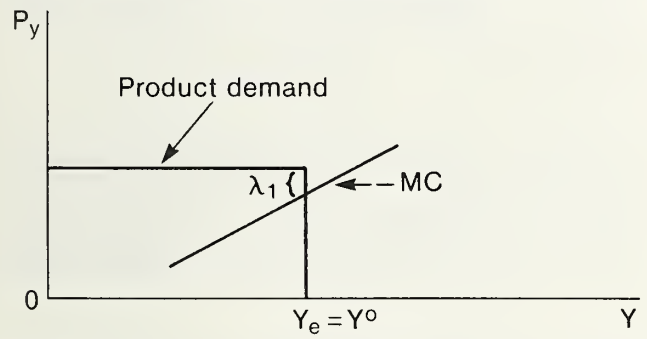
The point of the general model is that, given its assumption of rigid prices or rigid wages through a limited range of output or employment, the Marshallian supply and demand curves need not intersect in equilibrium except as a special case.

product demand accompanied by unemployment, the usual Keynesian case, can be restated as:

$$(P_y - \lambda_1) = P_x \frac{dX}{dY} \qquad (15)$$

where the right side is an expression of marginal cost. This rearranges the terms in equation (14).

The expression on the right side is interpreted as the Marshallian supply curve for products if the market is competitive. The Marshallian demand curve for products is the perfectly elastic segment for which the general price level equals P_y. The Marshallian supply and demand curves do not intersect in product market equilibrium in this situation. They differ from each other by the quantity λ_1. The situation in the product market may be diagrammed as follows:



Marginal revenue to each firm equals average revenue up to the point where the market is exhausted. At that point, a market imperfection bends the demand curve and marginal revenue falls to zero. Equilibrium is attained with price in excess of marginal cost in this imperfectly competitive market. The gap (λ_1) in the product market and the gap ($\lambda_1(dy/dx)$) in the factor market are two manifestations of the same market imperfection.

A remnant of the Marshallian product demand curve is apparent in the monopoly analysis, but the curve which described product supply in competition no longer performs that role; there is no schedule of quantities that will be offered at alternative prices. The marginal cost curve does not function as a product supply curve except in competitive markets. Robinson devoted her chapter 6 to what has happened to the supply curve in monopolistic markets. She listed several scenarios which could be assumed that would allow a supply curve to be identified. She concluded: "Although it is possible to draw up a supply curve on any one of these assumptions, there will be a different supply curve on each different assumption" (*10*, p. 87).

Keynes' scenario was one which trod upon the concept of consumer sovereignty and which gave the producer the balance of power in the bilateral monopoly confrontation between consumer and producer. If consumers had market power, when there was insufficient aggregate demand accompanied by unemployment, they could drive prices down by the quantity λ_1. If so, marginal cost would equal average price and the Marshallian supply and demand curves would intersect. Keynes recognized that prices can fall during slack times, but frequently do not. "Indeed," he said, "[the economic system] seems capable of remaining in a chronic condition of sub-normal activity for a considerable period without any marked tendency towards recovery or towards complete collapse . . . prices . . . seem to be able to find a level at which they can remain . . . moderately stable. . . . these facts of experience do not follow of logical necessity" (*7*, pp. 249-50). But the "facts of experience" are consistent with the scenario chosen by Keynes—that in which the monopolistic power of producers against consumers is sufficient to hold prices above marginal cost.

The general price level is supported by monopoly power. The forces of competition, were they effective, would decrease the price level by the quantity λ_1. Keynes defined administered prices, or monopoly prices, as "prices which are determined by other considerations than marginal cost" (*7*, p. 268).

Keynes' scenario of a stable general price level and stable wages when there is insufficient aggregate demand and persistent unemployment implies that λ_1 continues to be greater than zero, that average revenue exceeds average cost, and that monopoly profits accrue to the producer. Consumers fail to share in those profits if they cannot force a reduction in the general price level. Labor fails to share in those profits if it cannot force a rise in wages.

Keynes' policy prescription for a situation characterized by insufficient aggregate demand accompanied by unemployment was to shift the perfectly inelastic segment of the consumer demand curve to the right. Included in his methods for achieving this result was increased autonomous demand by business, government, or foreigners that would be accompanied by a multiplier effect in the household sector as

demand for workers shifts to the right, unemployment decreases, and income increases. Keynes' target for monetary and fiscal policy was to fix the perfectly inelastic segment of the demand curve so that:

- In the product market, λ_1 equals zero; the quantity which clears the market exactly equals the maximum allowed by the propensity to consume, and average price equals marginal revenue.

- In the factor market, $\lambda_1 (dY/dX)$ equals zero; there is full employment, and marginal value product equals average factor cost.

When these conditions hold, the equilibrium conditions of classical competition are satisfied as a special case of the general theory, and full employment is attained without inflation.

It is possible for equilibrium to be reached when there is unemployment, when there is unfulfilled demand, when λ_1 and λ_2 both equal zero, and when the competitive equilibrium conditions hold. Keynes did not discuss this situation, but, as already mentioned, Robinson recognized the possibility and Modigliani examined the situation carefully. Modigliani failed to recognize the product market imperfection caused by rigid prices, but he was explicit about the factor market imperfection caused by rigid wages, and he noted that this feature of the Keynesian theory "explains the consistency of economic equilibrium with the presence of involuntary unemployment" (*9*, p. 65). This is the competitive situation with persistent unemployment discussed above.

Keynes was also concerned with what would happen if the perfectly inelastic segment of the demand function shifted to the right beyond the level required to eliminate unemployment. His answer: "true inflation" (*7*, p. 303). This situation is the subject of the next section.

Inflation

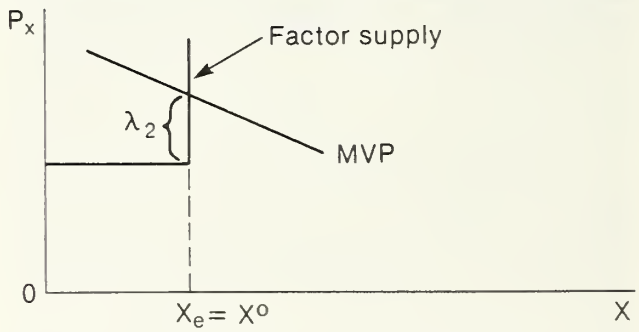
In his *General Theory*, Keynes paid greatest attention to the problem of insufficient product demand and periods of depression. The problem of insufficient factor supply and its relation to inflation was treated mostly in chapter 21 where he discussed the theory of prices. By the symmetry of the simple model presented here, we could just as well call this inflationary situation one of excess demand. In fact, that is the way Keynes looked at it.

The Factor Market

Consider the case for which $Y < Y^0$ (see equation (8)). This implies that $\lambda_1 = 0$. Consider that λ_2 is greater than zero (see equation (9)). Then it follows from $(\partial L/\partial \lambda_2)\lambda_2 = 0$ that $(\partial L/\partial \lambda_2) = 0$; therefore, $X = X^0$. That is, when λ_1 is zero and λ_2 is greater than zero, there is full employment and an excess of demand relative to available supply. One could also say of this situation that there is an insufficient aggregate supply relative to potential demand. The marginal condition for equilibrium in the factor market when insufficient supply—whether of labor or of petroleum—and unsatisfied demand exist is the following:

$$P_y \frac{dY}{dX} = P_x + \lambda_2 \qquad (16)$$

This rearranges the terms in equation (12) with $\lambda_1 = 0$. The expression on the left side is marginal value product. Equation (16) indicates that in the factor market the marginal value product of labor exceeds the average wage by the quantity λ_2. The situation of insufficient factor supply and excess demand may be diagrammed as follows:



In this situation, labor unions will strive to increase wages in the amount of λ_2. Management can pay the increase in wages out of profits accruing from the monopoly situation. If labor unions have the monopoly power to extract this wage increase from management and thereby to eliminate the monopoly profits to business associated with $\lambda_2 > 0$, classical competitive equilibrium conditions will obtain in the factor market in the sense that marginal value product will equal average factor cost, and there will be full employment.

Keynes' scenario was one which trod upon the concept of consumer sovereignty and which gave the producer the balance of power in the bilateral monopoly confrontation between consumer and producer.

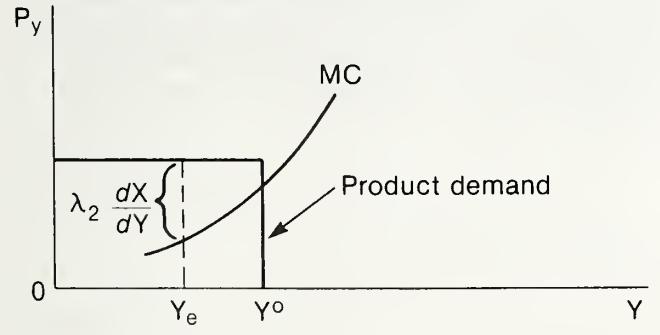
However, that is not the end of the story. It might have been if Keynes had felt that consumers could hold the line against product price increases. If they could, both λ_1 and λ_2 would equal zero, and income would be redistributed from business to labor to reach equilibrium. But, according to Keynes' inflation scenario in chapter 21, producer monopoly power against the consumer is strong enough to pass the wage increase along to the consumer through an increase in the general price level in an effort to maintain monopoly profits. To the extent that producers can do so, inflationary pressures will persist; additional rounds of higher wages will lead to additional rounds of higher product prices, λ_2 will continue greater than zero, and the Marshallian supply and demand curves will never meet.

The Product Market

Consider what happens in the product market during periods of insufficient factor supply and excess product demand. The marginal condition can be reformulated as:

$$P_y - \lambda_2 \frac{dX}{dY} = P_x \frac{dX}{dY} \qquad (17)$$

This equation is a rearrangement of the terms in equation (16). The expression on the right side is marginal cost. Equation (17) indicates that in equilibrium the product price exceeds marginal cost by the quantity $(\lambda_2(dX/dY))$. This product market situation may be diagrammed as follows:



If consumers had the power to decrease the general price level in the amount of $\lambda_2(dX/dY)$, perfectly competitive classical conditions for equilibrium would be restored by means of an income transfer favoring consumers. In Keynes' scenario, consumers do not have that power. In fact, he said that the producer monopoly power over the consumer was generally not only strong enough to hold the price line and maintain monopoly profits, but also strong enough to press for price increases in the event that wage increases must be granted to labor monopolies in the factor market.

To describe upward price pressures which originate in the factor markets before full employment is reached, Keynes applied the term "semi-inflation" (7, p. 301). This is not shown in the diagram. He explained such price pressures in terms of "the psychology of workers and the policies of employers and trade unions" (7, p. 301). This source of price change was part of Keynes' general view that prices are always subject to change, generally upward, whether or not there is full employment. He found the analogy of semi-inflation to absolute inflation an imperfect one.

The problem of what Keynes called absolute inflation (7, p. 301) arises when there is full employment and potential demand is greater than the economy's capacity to produce. The gap (λ_2) in the factor market and the gap $(\lambda_2(dY/dX))$ in the product market are two manifestations of the same market imperfections. By the symmetry of the simple model used here, the same analysis follows from interpreting $\lambda_2 > 0$, either as a situation of excess product demand or as one of insufficient factor supply. Keynes regarded this situation as an excess of product demand. Of inflation, which is demand driven, he said: "[if] a further increase in the quantity of effective demand . . . spends itself on an increase in the cost unit, we have reached a condition . . . of true inflation" (7, p. 303).

Conclusions

Three conclusions follow if the interpretation of Keynes presented here is correct. They relate to: (1) his contribution to monopolistic theory; (2) his scenario about the balance of monopoly power among consumers, business, and factor owners (or labor unions); and (3) the implications for merging Keynesian and neoclassical models.

Perhaps it is time to recognize the contribution that Keynes made to monopolistic theory so that he can take his place beside Chamberlin, Robinson, and other early contributors. His clear statement of a factor supply curve which is perfectly elastic up to the point of full employment, and perfectly inelastic at that point, introduces a market imperfection—an element of monopoly. The factor market imperfection asso-

ciated with rigid wages has a counterpart in the product market in two senses. First, the failure of Marshallian supply and demand curves to intersect in the factor market implies that they do not intersect in the product market either, whether prices there are considered flexible or rigid. Second, the product demand curve can be drawn as perfectly elastic up to the point of effective demand and perfectly inelastic at that point. In the case of rigid product prices, there is an explicit imperfection—an element of monopoly—in the product market as well.

The theory of monopoly says that Marshallian supply and demand curves need not intersect in equilibrium. There is no identifiable schedule of quantities that will be offered in the product market at alternative prices which can be interpreted as a product supply schedule. Similarly, there is no identifiable factor demand schedule in the factor market. Keynes' assumptions of market imperfections remove his model from competitive analysis. That he knew full well what he was doing is clear from his declaration of a need to controvert the economists' counterpart to the geometers' "axiom of parallels" and thereby to develop an economic theory which no longer assumes that competitive demand and supply schedules of prices and quantities intersect.

Neither oligopoly nor bilateral monopoly problems have unique solutions. Economists introduce uniqueness by assuming a scenario. Keynes solved this problem by setting up three monopolistic interest groups: consumers, producers, and labor. In the battle between consumers and producers, he gave the balance of power to producers. Of Keynes' three interest groups, consumers were the weakest with respect to market power. Consumers have little power to press for lower prices in a recession, and they offer little resistance to price increases in an inflation. In the battle between producers and labor, Keynes gave the balance of power to labor during full employment and inflation, but assumed a stand-off (or possibly a balance to producers) during slack times. He explicitly recognized that one is not logically compelled to accept his scenario. He apparently was also aware that some scenario was needed to close the theory and achieve a unique and acceptable solution; he apparently felt his scenario led to a more realistic model than the alternatives.

Many books and articles have been written seeking to reconcile Keynes with the classical economic theorists. The task has proven difficult. Researchers usually present the Keynesian model without making the price-quantity schedules in the monopolistic product and factor markets explicit; worse, they often present it without reference to the employment function or to the factor markets, and they focus on Keynes' redefined concepts of aggregate supply and demand in the product market. Efforts at reconciling Keynes with the classical economists usually reinstate competition; yet, it was Keynes' express intention to throw over this assumption. When efforts at reconciliation make the employment function explicit in order to connect the product market with the factor market, critics seldom recognize that Keynes' interpretation of the employment function (7, chapter 20) has the logic moving from product to factor, whereas the usual interpretation of the production function in classical theory, and also in what is coming to be called "supply-side economics," has the logic moving in the opposite direction, from factor to product. Keynes solved for equilibrium of aggregate supply and demand in the product market and then examined the labor requirement to determine whether the situation is one of unemployment or inflation; the classical model solves for equilibrium of Marshallian supply and demand in the factor market and then uses Say's Law to clear the product market of the resultant output.

Euclid's fifth postulate implies that one and only one parallel to a given straight line can pass through a given point. In consequence of this, space is assumed to be straight, not curved; we say that the sum of the internal angles of a triangle is 180 degrees. This postulate can be contradicted either by assuming that several parallels to a given straight line can pass through a given point, or that there are no parallels. In consequence, space is curved and the sum of the angles of a triangle may be either less or more than 180 degrees. Seeking to reconcile Keynesian theory with classical theory by first assuming perfectly competitive markets is analogous to seeking to reconcile Einstein's general relativity theory with Newtonian mechanics by first assuming that one and only one parallel to a given straight line can pass through a given point. Einstein's contradiction of Euclid's axiom of parallels led him to a general theory of relativity. Keynes' contradiction of the economists' "axiom of parallels" led him to a general—monopolistic— theory which, he felt, better explained the economic world in which we live than the special case of competition. To Keynes, the phrase "general theory" meant "monopolistic theory"; he might have entitled his book: *The Monopolistic Theory of Employment, Interest, and Money.*

Of Keynes' three interest groups, consumers were the weakest with respect to market power. Consumers have little power to press for lower prices in a recession, and they offer little resistance to price increases in an inflation.

References

(1) Bertrand, Joseph. "Théorie des Richesses," *Journal des Savants*, Sept. 1883, pp. 499-508.

(2) Chamberlin, Edward Hastings. *The Theory of Monopolistic Competition.* 8th ed. Cambridge, Mass.: Harvard Univ. Press, 1962. (Orig. publ. 1933.)

(3) Cournot, Augustin. *Researches into the Mathematical Principles of the Theory of Wealth* (trans. N.T. Bacon). Homewood, Ill.: Irwin, 1963. (Orig publ. 1838.)

(4) Edgeworth, Francis Y. "Pure Theory of Monopoly," *Papers Relating to Political Economy.* Vol. I. London: Macmillan, 1925. (Orig. publ. as "La Teoria Pura del Monopolio," *Giornale degli Economisti*, Vol. 4, 1897, pp. 13-31.)

(5) Galbraith, John Kenneth. *American Capitalism: The Concept of Countervailing Power.* Boston: Houghton Mifflin, 1952.

(6) Harrod, Roy F. "An Essay on Dynamic Theory," *Economic Journal*, Vol. 49, 1939, pp. 14-33.

(7) Keynes, John Maynard. *The General Theory of Employment, Interest, and Money.* New York: Harcourt, Brace and Co., 1936.

(8) Marshall, Alfred. *Principles of Economics.* New York: Macmillan, 1890.

(9) Modigliani, Franco. "Liquidity Preference and the Theory of Interest and Money," *Econometrica*, Vol. 12, No. 1, Jan. 1944, pp. 45-88.

(10) Robinson, Joan. *Economics of Imperfect Competition.* London: Macmillan, 1933.

(11) Sweezy, Paul. "Demand Under Conditions of Oligopoly," *The Journal of Political Economy*, Vol. 47, 1939, pp. 568-73.

(12) Von Neuman, John, and Oskar Morgenstern. *Theory of Games and Economic Behavior.* Princeton, N.J.: Princeton Univ. Press, 1944.

In Earlier Issues

The rapid growth in the volume of statistics . . . has been due largely to the collection of many additional data for use in administering governmental programs. Statistics . . . have been adapted for many uses for which they were not originally intended. Moreover, the growth of economic statistics . . . [is] unequal . . . and somewhat haphazard from the viewpoint of supplying the information most needed in making policy decisions . . . statistics must be developed to serve a purpose or need . . . statistics must provide facts that will help people in making decisions.

Raymond P. Christensen
Vol. 6, No. 4, Oct. 1954, p. 126

Research Review

Statistical Estimation of Firm-Level Demand Functions: A Case Study in an Oligopolistic Industry

By S. Shapouri, R. J. Folwell, and J. L. Baritelle*

Demand theory has occupied a prime place in economic literature. The statistical estimation of demand relationships has usually focused on industry or aggregate market levels, and researchers have used time series data and have assumed perfect competition. However, the lack of data from secondary sources and the cost of assembling data from primary sources have precluded analysis of demand at the firm level in a market with imperfect competition.

A recent marketing survey by the Economics and Statistics Service and Washington State University yielded a data set which enabled researchers to estimate firm-level demand function in an imperfect, competitive market. The principal objective of this research was to gain information on the marketing and consumption of U.S. wines. The results of this study lend credibility to the postulates of the theory of the firm under imperfect, competitive market structures.

Microeconomic Considerations

Price-quantity decisions of competitive firms are deterministic because of the atomistic character of the demand market; the firm is a price taker and, therefore, the demand function it faces is perfectly elastic.

The behavior of the firm in making price-quantity decisions is usually indeterminate in an imperfect, competitive market structure. In an oligopoly, this indeterminancy arises from the varying degrees of interdependence among the participants. Each oligopolist is aware (to varying degrees) that specific actions will lead to, or will stimulate, responses by rivals.

The individual firm in an oligopolistic market faces its own distinct demand curve (see *4*).[1] Thus, the quantity the ℓth firm sells depends on the pricing decisions of all firms (n) in the industry:

$$\overline{Q}_\ell = F_\ell(p_1, p_2, ..., p_n) \qquad \ell = 1, 2, ..., n \qquad (1)$$

The profit function (Π) of the ℓth oligopolist is:

$$\Pi_\ell = q_\ell f_\ell(p_1, p_2, ..., p_n) - C_\ell(q_\ell) \qquad (2)$$

The economist's efforts to analyze and predict firm behavior can appear confused when the oligopolist competes with rivals. For example, one way for the economist to ensure a deterministic solution would be to incorporate reaction functions for competing, rival firms' pricing decisions (equation (2)). It may also be necessary to make behavioral assumptions concerning the market share and the degree of product differentiation. Prices, product (quantities), quality and promotion (advertising) could all be major elements of a firm's demand curve.

In examining the theory of the firm under an imperfect, competitive market structure, we restricted our research to the price dimension as presented in equation (1), as information on product and promotion decisions of specific firms was not available. We anticipated that: (1) most firms face a demand function with approximately the same price elasticity as at the aggregate market level or at a slightly more price-elastic one; (2) some firms face demand functions with significantly greater price elasticity, and these firms charge lower prices; and (3) some firms face less price-elastic demand functions, and these firms charge higher prices. We expected that the prices of rival firms would be statistically significant in cases (1) and (2), where a firm faced a demand function that was at least as price elastic as the industry level.

We specified and estimated aggregate market-level or industry-level demand functions for various types of American wines. These functions generated information on the nature and elasticities of the aggregate market-level demand functions by wine type. Then, we specified and estimated demand functions by wine type for each major U.S. wine firm. We compared the firm-level demand functions with industry-level demand functions to confirm the oligopolistic structure of the market.

Method

We estimated the demand functions using cross-sectional, wine purchase data. The purchase data were reported monthly by a panel of 7,000 households. We used cross-sectional data from February 1975 through January 1976 to estimate industry-level demand functions. We used data from August 1975 to January 1976 to estimate the firm-level demand functions. Costs of compilation precluded recording brand data for the entire period. We estimated the functions using ordinary least-squares regression.

We specified the aggregate market or industry-level demand functions for each U.S. wine type. This specification was of a double-logarithmic functional form:

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[1] Italicized numbers in parentheses refer to items in the references at the end of this article.

$$ln Q_{ijk} = B_0 + B_1 ln Y_{jk} + B_2 ln P_{ijk} + U_{ijk} \quad (3)$$

where *ln* denotes the natural log value of the following variables: Q_{ijk} = quantity of the *i*th type of wine purchased in the *j*th month by the *k*th household per adult member (ounce/adult); Y_{jk} = the deflated income per adult in the *k*th household in the *j*th month ($1,000/adult); P_{ijk} = the deflated price paid per ounce for the *i*th wine type purchased in the *j*th month by the *k*th household (cents/ounce); U_{ijk} = random disturbance term; and B_0, B_1, and B_2 = ordinary least-squares estimated parameters. We deflated the income and price variables by the monthly Consumer Price Index for all items. The double logarithmic functional form provided the best statistical results over other functional forms—for example, the linear, inverse logarithmic, and semilogarithmic.

We estimated demand functions at the industry level for the major wine types: (1) varietal red, white, and pink table wines; (2) nonvarietal red, white, and pink table wines; (3) sherry, port, and other dessert wines; (4) champagne and other sparkling wines; (5) apple, berry, citrus, and other flavored wines; and (6) vermouth, flavored and natural brandies.[2] We included other wine types in earlier specifications of the demand functions as substitutes (equation (3)), but the prices of such substitutes were not statistically significant.

[2] Varietal table wine is made of at least 51 percent of the kind of grape after which the wine is named, and nonvarietal table wine is a blend of various varieties of grapes.

We specified the demand functions for individual firms (brands) by wine type as:

$$ln Q_{ijk\ell} = B_0 + B_1 ln P_{ijk\ell} + B_2 ln Y_{jk} + B_3 ln \overline{P}_{ij} + V_{ijk\ell} \quad (4)$$

where ℓ = ℓth brand of the *i*th type of wines; $\overline{P}_{ij}$ = the deflated, weighted-average price paid by all households for all other brands of the *i*th type of wine during the *j*th month; and $v_{ijk\ell}$ = the random disturbance term. We defined all the other variables as before. We estimated firm-level demand functions only for those nine firms that had a relative market share of at least 1 percent (table 1).

We treated each purchase by an individual household as an observation. If a household purchased some other brand of wine and not the brand considered, we did not treat as a zero purchase for that brand, but entered it as an observation in the data set we used to estimate the demand function for the alternative brand. Thus, the estimated functions are demand functions for purchases of a given brand.

The substitute prices we used in the firm-level demand functions were the average prices of all other brands in a region during a given month ($\overline{P}_{ij}$). The regions we used were the nine U.S. census regions (see 2). In earlier specifications, we used as separate explanatory variables the prices of other brands for the wine type which each specific household purchased rather than the average price for all competing brands We dropped this specification because a singularity ($X'X$) matrix made the estimation of the parameters using ordinary least-squares ($\beta = (X'X)^{-1}X'Y$)) impossible.

Table 1—Market shares and average prices, by U.S. wine company, August 1975 through January 1976

Wine type	Gallo	United Vintners	Franzia	Mogen David	Almaden	Guild	Taylor	Paul Masson	Christian Brothers	All firm average
Market shares:	*Percent*									
Varietal table	6.1	26.1	2.4	15.9	3.8	1.3	0.5	1.5	0.9	N.A.
Nonvarietal table	32.7	11.9	2.3	.1	5.5	4.7	2.3	2.0	1.6	N.A.
Dessert	39.4	8.7	.7	.1	4.4	3.5	15.2	3.8	3.3	N.A.
Flavored	50.4	13.6	.1	10.0	2.0	.6	2.1	1.0	.1	N.A.
All wine	32.9	12.9	2.0	2.8	4.5	3.8	3.6	2.0	1.5	N.A.
Average price:	*Cents per ounce*									
Varietal table	6.0	4.5	3.7	6.0	7.5	4.4	8.6	9.6	11.5	6.1
Nonvarietal table	4.1	4.6	3.8	5.1	5.6	3.6	7.3	7.3	6.6	4.3
Dessert	4.5	4.6	5.0	5.3	6.9	4.8	7.2	9.1	8.2	5.6
Flavored	4.5	4.9	9.6	5.9	5.0	4.4	7.8	7.6	8.4	5.2

N.A. = not applicable.

Industry-Level Demand Functions

Table 2 shows the estimated industry-level or the aggregate market-level demand functions for the major wine types. It presents the slope coefficients and their *t*-values. The slope coefficients associated with the price variables are negative, statistically significant, and between zero and −1. We retained explanatory variables with signs (in agreement with economic theory if the value of the standard error of the slope coefficient was less than the value of the slope coefficient. The results of our study show that the demand functions for each wine type at the U.S. industry level are inelastic with respect to price. The slope coefficients in the estimated demand functions are elasticity coefficients for the double-log functional form.

Firm-Level Demand Functions

Tables 3, 4, and 5 report the estimated demand functions for each wine type at the firm level. The signs of the slope coefficients conform to *a priori* economic theory; that is, the signs associated with the price of the wine type considered are negative, and those related to prices of substitute wines and to income are positive. We report only those slope coefficients or those cross elasticities for substitute wines that are statistically significant.

In the case of varietal table wines (table 3), only the price elasticity of the firm-level demand function for pink varietal table wines differ significantly[3] from that of the industry-level demand function (see footnote 3 of table 3). All the other firm-level demand functions have price elasticities which do not differ significantly from the aggregate market-level elasticity. United Vintners has the dominant market share for varietal table wines and has lowest prices (table 1).[4] Thus, we expected a more price-elastic demand function.

The lower part of table 4 shows the estimated firm-level demand functions for nonvarietal table wines. Comparisons of the price elasticities at the firm level with those at the industry level (table 1) reveal that if a firm-level demand function differs from the aggregate, market-level demand function with respect to price elasticity, the direction of difference is always toward greater elasticity. The other price elasticities are almost identical with those at the industry level. In four out of five cases, when the firm-level demand function was more price elastic, the prices of substitutes were significant.

The only firm-level demand function which was significantly less price elastic than the aggregate market-level demand function was that for Christian Brothers' nonvarietal, pink table wines. The average price Christian Brothers charged for nonvarietal table wines was among the highest in that product category.

Table 4 shows the estimated firm-level demand functions for sherry and port dessert wines. Only for Gallo sherry was the firm-level demand function less elastic than that at the industry level; however, the difference was not statistically significant. For all other firm-level demand functions for sherry, the price elasticities were greater than, or the same as, those for the industry level. Prices of substitutes were significant for two of the eight firms.

Comparisons of firm-level demand functions for flavored wines (table 5) with those at the industry level (table 1) indicate two groups in which the firm price elasticity was significantly greater than the industry price elasticity: Gallo and Mogen David berry wines.

Thus, our statistical estimation of firm-level demand functions in an oligopolistic market substantiate the anticipated theoretical results, which are based on the behavioral assumptions underlying conjectural variations for such a market situation. The nine firms studied faced demand functions that were not significantly different from those for the aggregate market. When an individual firm-level demand function differed from the aggregate market-level demand function, it tended to be more price elastic and the prices of substitutes (rival firms) were significant.

[3] To test for significant differences between pairs of slope coefficients, we used a *t*-test of the following form:

$$t = \frac{\beta i - \beta j}{V(\beta i) + V(\beta j) - 2\,\mathrm{Cov}\beta i\,\beta j}$$

The value of the covariances (Cov *i j*) was assumed to be zero.

[4] Use of brand names in this article is for identification only and does not imply endorsement by the U.S. Department of Agriculture.

Table 2—Market demand functions for U.S. wine types

Type	Slope coefficients[1]						Related statistics[2]				
	Intercept		Per capita income		Price		$\overline{Q}_{ij}$	n	R^2	S	S_y
	B_0	t	B_1	t	B_2	t					
			1,000 dollars		*Cents/ounce*		*Cents/ounce*				
Varietal table wines:											
Red	3.61	35.3	0.33	6.1	−0.77	−17.3	3.02	683	0.31	0.57	0.69
White	3.32	29.3	.34	5.8	−.64	−10.3	2.87	493	.19	.56	.62
Pink	3.68	29.2	.38	6.1	−.93	−12.7	3.12	381	.35	.50	.62
Concord	3.80	36.0	.15	3.5	−.86	−12.4	2.80	600	.21	.52	.58
Nonvarietal table wines:											
Red	3.84	101.1	.25	12.4	−.94	−44.6	3.19	4,035	.34	.61	.76
White	3.64	83.9	.33	14.2	−.89	−38.1	3.10	3,043	.35	.58	.71
Pink	4.01	110.8	.18	7.2	−.99	−47.3	3.32	2,616	.46	.57	.78
Dessert wines:											
Sherry	3.16	45.6	.22	7.00	−.51	−13.3	2.82	1,319	.15	.56	.62
Port	3.87	52.8	.17	4.8	−.90	−16.9	3.07	822	.27	55	.64
Sparkling wines:											
Champagne	2.84	15.9	.52	6.6	−.43	−5.5	2.85	436	.14	.67	.72
Cold Duck	2.80	17.8	.26	3.6	−.24	−3.6	2.75	351	.07	.56	.58
Sparkling burgundy	3.26	13.7	.20	1.9	−.41	−2.7	2.81	82	.09	.57	.59
Flavored wines:											
Apple	2.89	32.5	.15	3.7	−.35	−5.5	2.72	471	.09	.47	.49
Berry	2.84	33.1	.23	6.0	−.36	−6.6	2.69	534	.13	.45	.48
Citrus	3.59	35.5	.31	6.0	−.87	−15.7	2.93	581	.32	.55	.67
Vermouth	3.61	29.9	.02	[3].4	−.74	−9.3	2.72	325	.21	.45	.51
Brandy:											
Flavored	4.01	20.8	.04	[3].4	−.66	−7.5	2.59	44	.60	.31	.48
Natural	2.87	9.5	.26	2.1	−.31	−3.0	2.58	40	.28	.35	.40

[1] Parameters of the demand functions estimated via ordinary least squares.
[2] Related statistics: $\overline{Q}_{ij}$ = mean of the dependent variable; n = number of observations; R^2 = coefficient of determination; S = standard error of the estimate; and S_y = standard deviation of the dependent variable.
[3] Not statistically significant; the standard error of the slope coefficient is greater in value than the value of the estimated slope coefficient.

Table 3—Table wines: Firm-level demand functions

Wine type and firm	Slope coefficients[1]								Related statistics[2]				
	Intercept		Price		Per capita income		Substitute price		$\bar{Q}_{ijk\ell}$	n	R^2	S	S_y
	B_0	t	B_1	t	B_2	t	B_3	t					
			Cents/ounce		*1,000 dollars*		*Cents/ounce*						
Varietal table wines:													
Gallo:													
All types	3.78	12.4	−0.89	−4.0	0.16	1.1	. . .	. . .	2.83	83	0.17	0.44	0.48
United Vintners:													
Red	3.64	15.0 *	−.95	−9.6	.43	3.6	. . .	. . .	3.16	117	.49	.49	.67
White	3.17	10.0	−.81	−4.8	.50	4.5	. . .	. . .	2.89	39	.47	.37	.49
Pink	4.56	15.5	[3] −1.49	−7.1	.15	1.1	. . .	. . .	3.36	48	.54	.41	.60
Almaden:													
All types	3.56	8.3	−.80	−3.5	.37	2.0	. . .	. . .	2.94	41	.27	.51	.58
Guild:													
Red	3.12	4.2	−.42	[4] −.7	.40	1.1	. . .	. . .	3.37	10	.18	.46	.45
Paul Masson:													
Red	2.36	4.0	−.42	−1.5	.68	4.1	. . .	. . .	2.54	10	.71	.28	.46
Christian Brothers:													
Red	3.88	6.2	−.59	−1.9	. . .	. . .	. . .	. . .	2.70	10	.31	.39	.45
Mogen David:													
Concord	3.87	20.9	−.81	−6.1	. . .	. . .	. . .	. . .	2.78	179	.17	.56	.61
Nonvarietal table wines:													
Gallo:													
Red	3.86	45.4	−.99	−17.3	.23	5.8	. . .	. . .	3.19	805	.30	.55	.66
White	4.14	27.2	[3] −1.37	−16.3	.18	3.4	0.14	1.3	3.14	453	.38	.54	.68
Pink	4.07	37.1	[3] −1.24	−18.6									
United Vintners:													
Red	3.93	27.0	−.92	−10.7	.19	2.6	. . .	. . .	3.10	288	.29	.54	.63
White	3.57	24.4	−.96	−9.3	.39	5.6	. . .	. . .	3.16	252	.31	.51	.62
Pink	3.95	21.8	−.91	[4] −.3	.15	1.3	. . .	. . .	3.16	172	.34	.52	.64
Franzia Brothers:													
Red	4.00	12.6	−.77	−2.4	. . .	. . .	. . .	. . .	3.29	29	.17	.60	.65
White	3.08	7.9	[3] −1.32	−5.3	.39	2.9	.63	1.9	3.30	43	.46	.35	.45
Almaden:													
Red	4.08	15.3	−1.52	−9.8	.63	5.8	. . .	. . .	3.06	105	.56	.44	.65
White	4.24	14.3	[3] −1.59	−9.5	.45	4.2	.26	1.2	3.11	117	.38	.53	.68
Pink	4.25	10.0	−1.27	−4.7	.23	1.5	. . .	. . .	2.97	48	.38	.48	.60
Guild:													
Red	4.16	9.9	−1.96	−7.5	.38	3.4	.62	1.7	3.69	84	.45	.60	.79
White	4.16	12.4	[3] −1.82	−7.1	.62	3.6	. . .	. . .	3.31	49	.58	.48	.72
Pink	4.73	30.9	−1.15	−6.4	. . .	. . .	. . .	. . .	3.83	35	.55	.37	.54
Paul Masson:													
Red	3.43	4.7	−.97	−2.9	.19	1.1	.70	1.1	2.87	37	.26	.65	.72
White	3.17	6.6	−.74	−3.5	.19	1.1	.47	1.4	2.78	68	.21	.55	.61
Pink	3.72	10.0	−.91	−5.6	.16	1.1	.38	1.5	2.91	52	.41	.45	.57

See notes at end of table.

Table 3—Table wines: Firm-level demand functions (Continued)

Wine type and firm	Slope coefficients[1]								Related statistics[2]				
	Intercept		Price		Per capita income		Substitute price		$\bar{Q}_{ijk\ell}$	n	R^2	S	S_y
	B_0	t	B_1	t	B_2	t	B_3	t					
			Cents/ounce		*1,000 dollars*		*Cents/ounce*						
Christian Brothers:													
Red	4.10	13.0	-.88	-4.4	. . .	. . .	. . .	. . .	2.78	22	0.49	0.48	0.65
White	3.83	14.1	-.83	-6.1	.27	2.1	. . .	. . .	2.71	38	.39	.43	.54
Pink	3.95	27.4	[3]-.61	-6.6	. . .	. . .	. . .	. . .	3.11	33	.55	.42	.62

. . . = not available.
[1] Parameters of the demand functions estimated via ordinary least squares.
[2] Related statistics: $\bar{Q}_{ijk\ell}$ = mean of the dependent variable; n = number of observations; R^2 = coefficient of determination; S = standard error of the estimate; and S_y = standard deviation of the dependent variable.
[3] Indicates that the firm slope coefficient differs significantly at the 0.05 level from the industry slope coefficient; that is, the price elasticities differ significantly.
[4] Not statistically significant; the standard error of the slope coefficient is greater in value than the value of the estimated slope coefficients.

Table 4—Dessert wines: Firm-level demand functions

Wine type and firm	Slope coefficients[1]								Related statistics[2]				
	Intercept		Price		Per capita income		Substitute price		$\bar{Q}_{ijk\ell}$	n	R^2	S	S_y
	B_0	t	B_1	t	B_2	t	B_3	t					
			Cents/ounce		*1,000 dollars*		*Cents/ounce*						
Sherry:													
Gallo	2.98	9.4	-0.28	-4.5	0.37	4.2	. . .	. . .	2.94	237	0.16	0.53	0.58
United Vintners	3.01	4.7	[3]-1.78	-6.6	.35	2.5	1.05	2.5	2.90	66	.45	53	.70
Almaden	4.10	10.0	[3]-1.14	-4.7	.25	1.3	. . .	. . .	2.81	53	.31	.42	.48
Taylor	3.99	12.4	[3]-1.11	-6.2	.07	.9	.32	2.2	2.78	120	.27	.45	.52
Christian Brothers	3.21	9.0	-.53	-2.2	.26	1.6	. . .	. . .	2.69	33	.15	.36	.38
Port:													
Gallo	4.01	23.3	-.85	-5.4	. . .	. . .	. . .	. . .	3.05	165	.15	.60	.65
United Vintners	4.43	10.8	-1.45	-4.6	. . .	. . .	. . .	. . .	2.74	30	.37	.45	.56
Taylor	4.37	13.6	-1.23	-5.8	.30	4.0	. . .	. . .	2.83	69	.39	.37	.47

. . . = not applicable.
[1] Parameters of the demand functions estimated via ordinary least squares.
[2] Related statistics: $\bar{Q}_{ijk\ell}$ = mean of the dependent variable; n = number of observations; R^2 = coefficient of determination; S = standard error of the estimate; and S_y = standard deviation of the dependent variable.
[3] Indicates that the firm slope coefficient differs significantly at the 0.05 level from the industry slope coefficient; that is, the price elasticities differ significantly.

Table 5—Flavored wines: Firm-level demand functions

Wine type and firm	Slope coefficients[1]								Related statistics[2]				
	Intercept		Price		Per capita income		Substitute price		$\bar{Q}_{ijkl}$	n	R^2	S	S_y
	B_0	t	B_1	t	B_2	t	B_3	t					
			Cents/ounce		*1,000 dollars*		*Cents/ounce*						
Gallo:													
Apple	3.02	17.4	−0.13	−3.0	0.46	1.8	. . .	. . .	2.74	192	0.06	0.46	0.46
Berry	3.18	15.6	[3]−.81	−4.2	.30	3.5	. . .	. . .	2.73	80	.25	.37	.42
Citrus	3.77	15.8	−1.07	−11.6	.13	1.6	.19	1.7	2.99	162	.49	.45	.62
United Vintners:													
All types	3.59	21.5	−.62	−4.3	. . .	. . .	. . .	. . .	2.90	164	.10	.55	.58
Mogen David:													
Berry	2.68	5.0	[3]−.77	−1.3	.70	2.4	. . .	. . .	2.47	17	.30	.44	.49
Paul Masson:													
All types	2.96	2.8	−.90	−1.3	.70	2.4	. . .	. . .	2.47	17	.30	.44	.49

. . . = not applicable.

[1] Parameters of the demand functions estimated via ordinary least squares.

[2] Related statistics: $\bar{Q}_{ijkl}$ = mean of the dependent variable; n = number of observations; R^2 = coefficient of determination; S = standard error of the estimate; and S_y = standard deviation of the dependent variable.

[3] Indicates that the firm slope coefficient differs significantly at the 0.05 level from the industry slope coefficient; that is, the price elasticities differ significantly.

References

(1) Folwell, R.J., and J.L. Baritelle. "The Pricing of your Product . . .: An Economicst's View." Paper presented at the Fourth Wine Industry Technical Seminar, 1977.

(2) _____. *The U.S. Wine Market.* AER-417. U.S. Dept. Agr., Econ. Stat. Coop. Serv., 1978.

(3) _____. *Demographic Profile of Wine Purchasing Households and Market Structure in the U.S. Wine Industry.* Bulletin 842. Washington State Univ., College of Agriculture Research Center, 1977.

(4) Shapouri, S. "The Demand of U.S. Wines." Unpublished Ph.D. dissertation, Washington State Univ., Dept. of Agricultural Economics, 1978.

In Earlier Issues

Agricultural economics without question will ultimately be judged by how much it can help people solve their problems. Yet, in the last 15 years, agricultural economists have paid less and less attention to the vital problems and issues [of land problems and policies]. The refinements in marginal analysis, in particular, have little to offer in devising solutions for land problems and guiding the formulation of land policies. Yet decisions are always being made, and land policy is continually being formed or modified. It is difficult to avoid the conclusion that agricultural economists are abdicating their responsibilities in an area in which their training, research, and judgment should be of value.

Raymond J. Penn
Vol. 6, No. 4, Oct. 1954, p. 127

Predicting Debt Reschedulings in Developing Countries

By Eileen M. Manfredi*

Export credits permitting the delayed financing of imported goods are generally used by official agencies of exporting countries to stimulate foreign purchases. Credit offered by commercial suppliers is usually short term, whereas the official export credit sales program of the Commodity Credit Corporation (CCC) provides credit to foreign governments for U.S. agricultural exports for up to 36 months. The Government also tries to induce banks to provide more private financing by insuring some loans against nonrepayment for various commercial and noncommercial reasons. The increased number of reschedulings of external debts—that is, the change in the repayments schedule of previously contracted debts—by developing countries in recent years has made bankers less willing to assess "sovereign risk," for a country's default on payments. Thus, objective measures are needed to evaluate an individual country's probability of debt rescheduling.

Because of growing interest in using statistical models to predict debt reschedulings for a specific developing country for a given year, I compared the results of two models published in 1971 and 1977 (see (*3*)).[1] Applying 1972-77 data for 60 developing countries to the Frank/Cline discriminant function and to the Feder/Just logit analysis revealed two interesting points. First, there was no significant difference between the accuracy of predicting debt reschedulings in the years before the first major oil price increase by the Organization of Petroleum Exporting Countries (OPEC) and those for subsequent years. Second, the Feder/Just system worked far better than the Frank/Cline system because it includes a capital flows variable.

The Frank/Cline Model

The Frank/Cline quadratic discriminant function is based on the relationship between four external debt and trade variables in the form of the two ratios and a critical value determined from the sample countries (*2*). The sample included 26 countries and 13 reschedulings in the 1960-68 period. The equation (*4*) states that a country is predicted to reschedule in a given year if:

$$35.6\ X_1^2 - 342.8\ X_1 X_2 - 54.4\ X_2^2$$

$$+ 42.1\ X_1 + 73.1\ X_2 \geqslant 9.643$$

where:

X_1 = total debt service payments (principal plus interest) in year t divided by merchandise exports in year t; thus, X_1 = the debt service ratio (DSR).

X_2 = amortization payments (principal payments only) on the debt in year t divided by the total external debt outstanding, disbursed only, lagged 1 year, that is, in year $t - 1$; thus, X_2 = the amortization ratio (AMR).

The debt service ratio (DSR) is an important variable for assessing a country's debt problems because it measures that country's ability to finance debt service payments out of current export earnings. The operation, 1 - DSR, gives the proportion of export earnings left over to purchase imports without using other sources of foreign exchange. Debt service payments are a previously assumed contractual obligation at set maturity and interest rates. A high DSR, according to the Frank/Cline equation, increases the likelihood of a debt rescheduling; thus, it is a warning that a country is vulnerable to shortrun fluctuations in export earnings. Each country controls the level of new debt it incurs; therefore, the level of debt service payments (the numerator of the DSR) can remain constant or can change as the result of government policy. However, a country has limited control over the value of its annual exports. Thus, with a fixed numerator, any decline in the denominator will cause a rise in the DSR and further constrain a country's ability to import.

The amortization ratio (AMR) is a measure of the maturity structure of a country's external debt. A high AMR indicates a short, average repayment period or a bunching of maturities which are about to come due that may cause financial problems unless new loans are extended. A high AMR indicates a higher concentration of borrowings from private sources than from official sources, which tend to have longer maturities. Although repaying in a shorter period puts greater strain on a country's foreign exchange earnings, a high AMR may indicate that the country has excellent economic growth potential because of its ability to attract loans from private sources. A high AMR, according to the Frank/Cline equation, decreases the likelihood of a debt rescheduling. In general, countries with low AMR's are also those with the lowest per capita incomes and the least developed economies. They depend almost entirely on foreign aid for capital inflows.

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[1] Italicized numbers in parentheses refer to items in the references at the end of this article. Here I employ the original coefficients of the two models without attempting to reestimate them.

New Analysis with Frank/Cline Equation

Using 1972-77 data, I reapplied the Frank/Cline discriminant function to 60 countries (a wider group than previously), and I compared predictions of debt reschedulings with actual multilateral reschedulings (table 1). The ability of the equation to predict debt reschedulings correctly has not changed since its formulation in 1971. However, both the number and percentage of type I errors (failures to predict a rescheduling) and type II errors (failures to predict no rescheduling) vary widely each year. This variability of the equation in correctly predicting debt reschedulings could result from missing variables that were not modeled by Frank/Cline. Either other economic variables compensate for those in the Frank/Cline function so that a country exhibiting a type II error can avoid reschedulings or that country will have taken some policy steps to preclude rescheduling.

A sharp rise in the DSR in one year is a characteristic of countries that the Frank/Cline model predicts would have rescheduled but that did not. Usually, the faulty prediction was due to an unexpected deterioration in export earnings (as for Zambia in 1977) or to a large debt service payment for 1 year (as for the Sudan in 1975). A rescheduling can be avoided if the economic effects are short term and if other capital flows can be tapped or if foreign exchange reserves can be drawn down for that year. Other countries avoided such predicted reschedulings each year by attracting large private capital inflows (for example, Mexico) or by obtaining large foreign aid grants (for example, the Yemen Arab Republic). Other variables and policies, such as financing from the International Monetary Fund, were not accounted for in the Frank/Cline function.

The Feder/Just Model

The Feder/Just model was based on logit analysis which uses a binary-valued, dependent variable (*1*). For each country in any given year, the probability of rescheduling can be predicted by the following equation, which is based on 1965-72 data for 41 countries and 21 reschedulings:

$$\ln\frac{P}{1-P} = 59.2\,X_1 + 0.4\,X_2 - 39.6\,X_3 - .01\,X_4 - 2.9\,X_5 - 52.6\,X_6$$

where:

- P = probability of rescheduling debt;
- X_1 = debt service payments divided by exports of goods and services (DSR);
- X_2 = imports divided by total international reserves (including foreign exchange and gold holdings);
- X_3 = amortization payments divided by total debt outstanding, including undisbursed debts (AMR);
- X_4 = per capita income;
- X_5 = total capital inflows divided by debt service payments; and
- X_6 = growth rate of merchandise exports in previous 8 years.

Table 1—Frank/Cline discriminant function, 1972-77

Indicator	1972	1973	1974	1975	1976	1977
	Countries					
Predicted reschedulings	11	8	6	11	7	11
Actual reschedulings[1]	2	2	4	2	2	1
Correctly predicted to reschedule	1	2	0	1	0	1
Correctly predicted not to reschedule	48	52	50	48	51	49
Missed reschedulings (type I error)[2]	1 (50)	0 (0)	4 (100)	1 (50)	2 (100)	0 (0)
False predictions (type II error)[3]	10 (17)	6 (10)	6 (11)	10 (17)	7 (12)	10 (17)
Total number of countries	60	60	60	60	60	60

Note: Numbers in parentheses are percentages.
[1] Multilateral debt reschedulings.
[2] The percentage of type I errors is calculated from the ratio of missed reschedulings to actual reschedulings.
[3] The percentage of type II errors is calculated from the ratio of false predictions to the actual number of countries that did not reschedule.

All variables, except debt service payments and exports, are lagged 1 year.

Two of the six variables used by Feder/Just are the same as those used by Frank/Cline, except for minor differences in definition. In the Feder/Just formula, X_1 includes exports of merchandise sales alone; X_3 uses a denominator of all external debt outstanding (including undisbursed debts).

X_2 is the ratio of imports to reserves. As accumulated foreign exchange reserves are another means (in addition to export earnings) of paying for debt servicing, they should be included in predictions of reschedulings. However, the level of reserves should be included as a ratio so that comparisons of a specific country's reserve position can be made across countries and over time. As reserves are generally considered a buffer to pay for imports in times of low export earnings, it is common to use an imports-to-reserves ratio.

X_4 is the level of per capita income. It is related to the past growth of the domestic economy. When X_4 is used as a separate variable, the growth of the domestic economy is not significant because, in most developing countries, it is highly correlated with export growth, which is a separate variable. However, the per capita level of income is significant; a high level indicates a greater ability to reduce imports of consumer goods to pay for debt servicing.

X_5 is the ratio of all capital flows to debt service payments. In many poorer countries, capital flows—especially grants and official loans—equal or surpass the value of annual export earnings. Therefore, capital flows can explain how a country with a high DSR or other unfavorable indicators can manage to avoid debt rescheduling in a given year. The ratio is a good short-term indicator of a country's ability to meet debt service payments. However, the flow of external capital from all sources is extremely variable. This ratio may fluctuate widely from year to year for a given country; in several cases, when capital outflows exceeded inflows, the ratio was negative.

X_6 is the growth of exports over the previous 8 years. This dynamic variable contrasts with the static use of exports as a denominator in X_1. Because export earnings are the primary stable source of funds for making debt service payments, a good growth rate is a favorable economic indicator.

The signs of the coefficients in the Feder/Just formula are the same as those predicted from theory; that is, high values for X_1 and X_2 lead to a greater probability of rescheduling, as the coefficient signs are positive and as in each case a high ratio implies a lower debt servicing capacity. For X_3 to X_6, high values imply a lower probability of rescheduling, as the coefficient signs are negative. For X_3, a high ratio implies a long-term debt problem, but it does not imply a need for immediate rescheduling. For X_4 to X_6, higher levels and ratios imply a better ability to service debt and, therefore, a lower probability of rescheduling.

Evaluation of New Analysis

Table 2 gives statistics on predictions of reschedulings, enabling us to compare the Feder/Just logit analysis with actual reschedulings.

The Feder/Just model had less annual variability than the Frank/Cline model in terms of type I errors—that is, the failure to predict countries which actually rescheduled; it showed an improvement in the latter half of the study period. However, its average of type I errors for the 6-year period was no better than that in the Frank/Cline model. The real strength of the Feder/Just system is its superiority in minimizing type II errors—that is, false predictions of reschedulings. The Feder/Just system falsely predicted 17 of 325 reschedulings, with an average error rate of 6 percent over the 6-year period. The Frank/Cline model falsely predicted 49 of 360 reschedulings, with an average error rate of 14 percent.

An analysis of changes in the variables and of the rescheduling probabilities for the sample countries during the 1972-77 period shows that deterioration in X_1 (debt service ratio) and in X_5 (capital flows ratio) generally caused a country to move from a zero or a low probability to a high probability. Countries predicted to reschedule tended to have high debt service and import-to-reserve ratios and low per capita incomes and capital flows ratios. An outflow of capital funds from a country facing adverse economic or political conditions was decisive in many cases in predicting a rescheduling. Table 3 shows the range of values for each variable for all the rescheduling predictions.

The capital flows variable, with its sharp changes in magnitude and direction, gives the Feder/Just model a greater degree of annual variation in the probability of rescheduling and fewer false predictions than does the Frank/Cline model. Many countries with unfavorable levels for other variables can avoid rescheduling their debts if they can maintain capital inflows at a high rate. Continuous flows of grant aid to the poorest countries and private capital flows to the developing countries with higher incomes can serve this purpose. The other

Table 2—Feder/Just logit function, 1972-77

Indicator	1972	1973	1974	1975	1976	1977
			Countries			
Predicted reschedulings (P > 0.5)	4	5	3	3	4	7
Actual rescheduling[1]	2	2	4	2	2	1
Correctly predicted to reschedule	0	1	1	1	1	0
Correctly predicted not to reschedule	49	49	49	51	50	42
Missed reschedulings (type I error)[3]	2 (100)	1 (50)	3 (75)	1 (50)	1 (50)	[2] 0 (0)
False predictions (type II error)[4]	3 (6)	3 (6)	1 (2)	1 (2)	3 (6)	6 (12)
Total number of countries[5]	55	55	55	55	55	50

Note: Numbers in parentheses are percentages.
[1] Multilateral debt reschedulings.
[2] The Zaire rescheduling in 1977 was not counted as a miss because of the lack of necessary data for a probability.
[3] The percentage of type I errors is calculated from the ratio of missed reschedulings to actual reschedulings.
[4] The percentage of type II errors is calculated from the ratio of false predictions of reschedulings to the actual number of countries that did not reschedule.
[5] Although 60 countries were initially included, some missing data excluded 5 countries in the 1972-76 period and 10 countries in 1977.

Table 3—Ranges of variables for rescheduling predictions

Variable	Actual values			Values multiplied by Feder/Just coefficients[1]			
	High	Low	Median	High	Low	Median	Range
X_1 Debt service ratio	0.402	0.016	0.167	+23.8	+0.947	+9.89	23.0
X_2 Imports: reserves	99.2	2.06	7.33	+39.7	+.824	+2.93	38.9
X_3 Amortization ratio	.195	.015	.063	-7.72	-.594	-2.49	7.13
X_4 Per capita income	1,070	100	230	-10.7	-1.00	-2.30	9.70
X_5 Capital: debt service	3.24	-9.5	1.08	-9.40	+27.6	-3.13	37.0
X_6 Export growth rate	.220	-.03	.056	-11.6	+1.58	-2.95	13.2

[1] The signs are from the Feder/Just coefficients; however, high, low, and median are listed as corresponding to the actual values multiplied by the coefficients. For example, the low actual value for X_5(-9.5) times the coefficient (-2.9) equals +27.6. In that case (Mauritius, 1977), the *ln* (P/1 - P) = 0.947 + 1.86 - 0.594 - 6.8 + 27.6 - 11.6 = 11.4, and the probability of rescheduling was 1.

countries—those not receiving large flows of foreign aid and those not achieving sufficient export and domestic growth to attract private capital—tend to reschedule their external debts.

Table 4 gives the values for each of the six Feder/Just variables for those countries which had multilateral debt reschedulings during the 1972-77 period. All the variables, except X_3, show a wide range between the high and low values.

However, if the highest and lowest values are eliminated, we can see that those countries which rescheduled tended to have the following characteristics: (a) debt service ratios of 11 to 16 percent; (b) import to reserve ratios of 2.9 to 5.4; (c) amortization ratios of 0.02 to 0.03 (indicating long-term debts averaging 30-50 years maturity); (d) per capita incomes of $120-$300; (e) capital inflows to debt service ratios of 1 to 2 (indicating little net inflow left over); and (f) annual export growth rates of 6-13 percent.

Table 4—Values of variables for rescheduling observation

Year and country	X_1	X_2	X_3	X_4	X_5	X_6	P
1972:							
Chile	0.100	4.80	0.026	760	0.339	0.072	0.004
Pakistan	.211	5.28	.022	130	4.300	.065	.030
1973:							
India	.191	2.06	.034	120	.940	.055	.981
Pakistan	.147	2.57	.022	110	2.090	.036	.448
1974:							
Chile	.115	7.37	.060	720	.490	.060	.012
Ghana	.037	2.88	.023	300	.042	.130	.001
India	.167	3.39	.037	120	1.130	.059	.900
Pakistan	.138	2.46	.022	120	2.350	.069	.034
1975:							
Chile	.286	23.00	.080	1070	-1.34	.160	1.000
India	.126	4.66	.034	120	1.89	.135	.003
1976:							
India	.109	5.44	.031	140	2.07	.136	.001
Zaire	.113	18.10	.021	130	1.08	.055	.997
1977:							
Zaire	.100	12.9	.072	130	. . .	. . .	. . .
High value	.286	23.00	.080	1070	4.30	.160	1.000
Low value	.037	2.06	.021	110	-1.34	.036	.001
Median value	.126	4.80	.031	130	1.13	.069	.034

. . . = Data not available.

All those countries with multilateral debt reschedulings in the period had positive, although occasionally low, probabilities of rescheduling with the Feder/Just model. The Feder/Just model generally assigned a high probability of rescheduling to countries that actually rescheduled.

Conclusion

Of the two prediction systems, the one with the capital flows variable (X_5 in the Feder/Just Model) did a better job of avoiding false predictions—that is, of indicating countries for which capital flows offset other unfavorable indicators. The interrelationship of many indicators is important; using the debt service ratio without other variables leads to overpredicting debt reschedulings. Although the Feder/Just model is superior to the Frank/Cline model because it produces fewer type II errors, further work is needed to lower type I errors. Using the Feder/Just model is a simple way to judge a country's external financial position and creditworthiness. A more dependable system would require reestimating coefficients with the most recent data and also experimenting with other variables, different lag structures, and other mathematical forms.

References

(1) Feder, Gershon, and Richard E. Just. "A Study of Debt Servicing Capacity Applying Logit Analysis," *Journal of Development Economics*, Vol. 4, Mar. 1977, pp. 25-38.

(2) Frank, Charles R. Jr., and William R. Cline. "Measurement of Debt Servicing Capacity: An Application of Discriminant Analysis," *Journal of International Economics*, Vol. 1, Feb. 1971, pp. 327-44.

(3) Manfredi, Eileen M. "Predicting Debt Reschedulings in Developing Countries." Unpublished Master's thesis, Virginia Polytechnic Institute and State University, 1980.

(4) Smith, Gordon W. *The External Debt Prospects of the Non-Oil-Exporting Developing Countries: An Econometric Analysis.* Overseas Development Council Monograph No. 10. Washington, D.C., 1977.

Special Lectures in Economics

As delivered by E. B. Wilson, John R. Commons, John D. Black, and Frank H. Knight before the Graduate School, U.S. Department of Agriculture, February-March 1930. 45 pages.

Reviewed by Harold F. Breimyer*

A question to be asked about the content of any scientific discipline at any time is: What part is temporal, and what part is perennial?

A review of four lectures delivered a half-century ago reveals which topics have proved to be only of-the-moment and which have persisted. The test can also be reversed: we can learn which issues in the early eighties have half-century antecedents, suggesting that they may remain with us a while longer, and which are new.

The 1930 lectures by distinguished scholars were intended to enhance the prestige of two then-young institutions—the USDA Graduate School and the Bureau of Agricultural Economics (BAF). Both have survived—the former intact, the latter imperfectly in a series of reorganizations.[1]

The Four Speakers

The four speakers were truly distinguished. E.B. Wilson was president of the Social Science Research Council. John R. Commons was the renowned institutional economist at the University of Wisconsin, aging, but still a firebrand. John D. Black, after moving from the University of Minnesota, had achieved eminence at Harvard. The younger Frank H. Knight was on his way to economic fame at the University of Chicago. In the late thirties Black was a frequent USDA lecturer; the others were rarer guests of the Department.

Students of economic thought will remember that in 1930 classical and neoclassical ideas rivaled for acceptance. Chamberlin and Robinson had not yet published their theories of monopolistic and imperfect competition, and J.M. Keynes was an obscure Englishman deeply involved in denying that Germany could or should pay World War I reparations.

Also, at the time of the USDA lectures, only 6 months had elapsed since the stock market crash, unemployed people had scarcely begun to sell apples for a nickel on city sidewalks, and the impending Great Depression was not on these four scholars' minds. Worth noting with whimsy, however, is the forgotten fact that the late twenties were supposed to usher in a New Era. What an era it (the thirties) turned out to be!

Furthermore, contemporary events were largely neglected. Three speakers, sensitized to the needs of the nascent BAE, addressed the nature of science and the scientific method. Frank Knight was more interested in human nature. As economic events revolve around the behavior of human beings, said Knight, those bipeds are the proper target of analysis.

The Four Research Approaches

Amazingly, the speakers offered the new BAE no heady optimism. They were chary about applying the scientific method to economic data. Ironically, this viewpoint was the only consensus among them. The four shared few common idioms. Wilson, in fact, began by saying that the biggest problem is definition. Implicitly, the other three corroborated, as each did his own definitional "thing." (Is there common language in economics today? Probably not.)

Perhaps the best coinage is to classify the four scientists' ideas for research proposals as: (1) institutional, (2) mathematical, (3) statistical, and (4) qualitative. Dividing the mathematical and statistical may seem strange to us but a distinction was made, notably by Wilson. Presumably mathematical is the generic concept, and statistical is a specific application.

For what must have been the 99th time, John R. Commons restated his institutional thesis. He then stood by, awaiting attack—which came. Like Knight, Commons began with an evaluation of human nature, which he then converted to a denunciation of the premises of classical economics. Human beings are irrational and selfish. There is no "preordained harmony of individual interests" as Adam Smith supposed. Moreover, as early as 1798, Mathus had "attempted to disillusion the economists" who saw man as rational. Man "is a being of passion, stupidity, and justification." Therefore, the only recourse is to accept "concerted action in control of individual action," the essence of institutionalism.

John D. Black, who had studied at Wisconsin, treated the ideas of Commons gingerly, but negatively. They never go beyond "qualitative terms," he complained. Frank Knight was less biting. In fact, "there is much justification for an 'institutional' approach. . . ." But Knight believed it would take us only a little way toward analytical discreteness. (Knight doubted very much else would, as noted below.)

In 1930 BAE economists were experimenting with mathematical tools in general and statistical analysis in particular. Despite the prominence already earned by Mordecai Ezekiel

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[1] BAE was the founding agency of the current Economics and Statistics Service (ESS).

and Elmer Working in correlation techniques, the four speakers were less than enthusiastic. Said Wilson, "The mathematical method is not yet through in economics . . . but it is likely largely to remain the work of a small fraction of students of economics." Commons vouchsafed only a quick satirical comment: economists, like physicists, he alleged, are becoming anxious that their science may be "resolved into nothing but pure mathematics. . . . We are being enticed into pure number." Black endorsed all quantitative studies, then regretted that data are usually inadequate.

Knight, Wilson, and Commons shared distrust of statistical techniques, and for similar reasons. Knight, the philosopher-economist, was by far the most eloquent. He declared as his main theme "the contrast in character and method between the natural sciences and those which deal with man in society. . . ." Further, "The root of the difficulty in regard to explaining and controlling human beings is the fact that the explainers and controllers are likewise human beings." Wilson was sure "periodogram" analysis could be applied to the stars but feared economic phenomena were not that dependable. "Time series are treacherous."

Knight cited with approval the Kantian vision of a conflict between "the mechanical and ethical view of human nature." Also engaging, but too involved for futher comment here, are Knight's notes on the "problematic" in human affairs. In human behavior, "the ends of action are problematic in about as great a degree as the means." (Then what can be treated as given, as exogenous? we could ask.)

Not surprisingly, Knight concludes that economic analysis is more an art than a science, and "we should learn from the way in which the arts are learned and taught rather than from physical science and engineering technique."

With regard to qualitative approaches in general, the four scholars were respectful. Knight stressed "meaning" in economic events. Black ticked off genetics (essentially historical), case study, and other methods, all approvingly. But Black turned sardonic when he complained that even qualitative analysis has pitfalls because "very few economists know about logic."

The four essays are prosaic in places, yet sparkle with occasional gems. During the seventies, economic thought suffered a blow as inflation undercut the deficiency-of-purchasing-power ideas that were a legacy of the Great Depression and a mainstay of Keynesian thought. (Now the popular slogan is supply-side economics or reindustrialization.) It is, therefore, significant that Commons, always prescient, anticipated the purchasing power theme as early as February 1930. His sharp logic is engaging. It was discovered during the break in farm commodity prices after World War I, he observed, that "not food was scarce, but purchasing power. . . ." Moreover, "purchasing power is an institution. Food is a commodity."

The Commons doctrine that still carries a punch today is that the courts are the most influential economic institutions, the Supreme Court above all. Commons insists that the Supreme Court "has in its hands the exercise of two powers of sovereignty . . . the mandatory and the injunctive power." But among institutions classed as fairly new in 1930, "the most powerful" was "doubtless the Federal Reserve System."

The final vignette is a line from Wilson, who complained that economic analysis is made difficult because nothing stays put. Doubtless with tongue in cheek he suggested that what was needed was "a prolonged period of relative stagnation [as it] might help toward the discovery of some economic laws. . . ." Yet he could not stay with it; he added a caveat that such an experience might tempt "to a feeling of security with its inevitable resulting dogmatism."

That note invites 50-year updating. Whatever else may be said about the ensuing half-century, it has not been one of constancy. Not dogma, but disputation, surely marks economic theory today. Perhaps, despite Wilson's fears, we too would like a breathing space of stability; we might get our theorizing in some degree of order.

Which of the issues of 1930 have proved lasting, perennial? Possibly, just possibly, we have a little more faith in analytical technique than the four authors expressed in 1930. Nonetheless, conceptualization of the scientific method and its applicability in a field where human behavior plays so instrumental a role are surely interminable issues. Is economics a science? Not a few scholars still ask.

Analysis of Economic Time Series: A Synthesis

Marc Nerlove, David M. Grether, and Jose L. Carvalho, New York: Academic Press, 1979. 480 pp. $29.50

Reviewed by Robert V. Bishop*

A question that comes immediately to mind when one reads this text is: "For whom was it written?" The ideas that the authors have collected from many sources and have surveyed here are of tremendous importance to applied researchers, but their exposition—with its emphasis on spectral methods—is probably quite unfamiliar to many members of this large potential audience. For those familiar with spectral analysis and the methodology of time series analysis as developed by Box and Jenkins (*1*),[1] this book provides an excellent (although often challenging) text. For others, it is probably not very useful.

The chapters vary in readability; some are quite lucid, while others are obtuse. However, all are relevant for economic researchers and present important considerations for this group to ponder.

The authors begin with a brief, but interesting, historical description, recalling the development of the conceptual framework and empirical methodologies from which researchers may model unobserved components in economic data. The decomposition of an observed data series into its trend, cyclical, seasonal, and irregular "unobserved" components is far from being new to economists; however, its rich, though controversial, history provides interesting reading.

The authors introduce spectral analysis of a single time series early in their text and present different hypothetical spectral density functions;[2] their material is quite technical, and they provide two appendixes to help the reader. Appendix B, "Some Requisite Theory of Functions of a Complex Variable," reviews the elements of the theory of complex variables, and appendix C provides "intuitive" insight into the Fourier transform. Much of the text is devoted to using spectral techniques to examine data in the frequency domain. Therefore, an understanding of this material is essential if one is to benefit from this section, or even from the remainder of the text.

The authors provide a number of innovative extensions of the time series methodology suggested by Box and Jenkins (*1*), using the "frequency domain" as a vehicle for "identifying" or, as the authors prefer, "formulating" the appropriate orders of the moving-average and/or autoregressive components that characterize the series being tested. Their discussion is extremely helpful as this "formulation" is not at all straightforward in the time domain when the appropriate model is of a mixed, autoregressive, moving-average (ARMA) characterization.

They give considerable attention to the "correction" of data to remove seasonality. They build on earlier studies (*2*, *4*), and their analysis is relevant for anyone who uses economic data. They note the essential considerations which researchers confront when they must choose between "raw" unadjusted or seasonally adjusted data (such as that transformed by the Bureau of the Census X-11 procedure). One example of the problem a researcher might face when using adjusted data is the case of overadjustment—that is, when the series has too much of the "seasonal" component extracted. One can view this as the excessive removal of power at the seasonal frequencies, thus resulting in "dips" in the power spectrum at those frequencies. The authors note that:

> While this was not regarded as especially serious in and of itself, corresponding to the dips, there must exist intermediate peaks at frequencies between the seasonal ones. Such peaks, if large enough, might induce spurious fluctuations in the adjusted series—a disturbing possibility (p. 150).

A paper by Wallis (*6*), not referenced by the authors, describes this overadjustment problem in the time domain as resulting in negative autocorrelation in the regression residuals of an order determined by the period of the seasonal component that has been "removed" (that is, removing seasonality in quarterly data often leads to negative fourth-order autocorrelation in the residuals). The authors report a result from Nettheim (*5*) that describes a case in which turning points in a series which had undergone a correction for "overadjustment" differed by as much as 2 to 3 months from those in the seasonally overadjusted series. They offer several ideas on seasonal adjustment, but obviously much work remains to be done before an "optimal" seasonal adjustment mechanism can be defined.

Later they describe the formulation of distributed lag models in the following manner:

> The extent and variety of topics to which distributed-lag analysis has been applied in empirical

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[1] Italicized numbers in parentheses refer to items in the references at the end of this review.

[2] The spectral density function is the Fourier transform (described in appendix C) of the autocorrelation function of the variable under test.

> economics is astounding, but what is more remarkable is the virtual lack of theoretical justification for the lag structures superimposed on basically static models. This extraordinary neglect of the dynamic underpinnings of the models actually fitted to the data is what Griliches (*3*, p. 42) has called "theoretical ad-hockery" (p. 291).

I believe that their comment is quite appropriate and expresses one of the major problems currently faced by economic model builders. It addresses the necessity of moving away from contrived lag-structures, which are often specified only to provide values needed for "future" right-hand side variables so an "econometric" model will "solve" for some forecasted period, and of moving toward a recognition of the way in which expectations are actually formed. To this end, the authors briefly describe several early "expectations" models—such as the cobweb model, the extrapolative expectations model, and the adaptive expectations model. These early models contrast with the rational expectations model, which currently permeates much of the technical economic literature. They define rational expectations as "expectations or forecasts (that) are simply the conditional expectations of the variable being forecast, based on all observations of it and related variables up to the time of the forecast" (p. 292). They develop the concept of quasi-rational expectations (which arise when anticipated endogenous variables are replaced by forecast variables), and they demonstrate ways in which these might be generated.

One area the authors do not address is the concept of Granger Causality. I mention this omission because most tests of the rational expectations hypothesis are derived from this important methodology. It is thus a serious oversight.

The authors conclude their text with a time series model for the U.S. cattle industry that introduces an objective function which is maximized over time. Computational difficulties with this approach restrict its application, but it appears to be a promising area.

The book offers much to the researcher who has some background in sophisticated time series modeling and spectral analysis, and it serves as an excellent reference text in that field. It might be a good supplemental text for an advanced econometrics course, and the individual who works through it may gain considerable insight into many of the problems that have plagued economic researchers for decades.

References

(1) Box, G.E.P. and G.M. Jenkins. *Time Series Analysis: Forecasting and Control.* New York: Holden Day, 1976 (rev. ed.)

(2) Grether, D.M. and M. Nerlove. "Some Properties of 'Optimal' Seasonal Adjustments," *Econometrica*, Vol. 38, 1970, pp. 682-703.

(3) Griliches, Zvi. "Distributed Lags: A Survey," *Econometrica*, Vol. 35, 1967, pp. 16-49.

(4) Nerlove, Marc. "Spectral Analysis of Seasonal Adjustment Procedures," *Econometrica*, Vol. 32, 1964, pp. 241-86.

(5) Nettheim, N.F. "A Spectral Study of 'Overadjustment' for Seasonality." Working paper No. 21. U.S. Department of Commerce, Bureau of the Census, 1965.

(6) Wallis, K.F. "Testing for Fourth Order Autocorrelation in Quarterly Regression Models," *Econometrica*, Vol. 40, 1972, pp. 617-36.

The Planning of Investment Programs in the Fertilizer Industry

Armeane M. Choksi, Alexander Meeraus, and Ardy J. Stoutjesdijk. Baltimore: Johns Hopkins University Press, 1980. 333 pp. $16.95 (cloth), $6.95 (paper).

Reviewed by Robert B. Rovinsky and David A. Torgerson*

Several years ago, the World Bank began producing publications detailing several of their planning methodologies and applications. This volume, by three staff economists at the Bank, is one of a series that deals with the use of mathematical programming in investment analysis. Its methodology closely follows that adopted in the first volume of the series (*The Planning of Industrial Investment Programs: A Methodology* by D.A. Kendrick and A.J. Stoutjesdijk), and builds a standard, medium-sized, linear programming model designed to analyze and plan fertilizer investment strategies. We have serious reservations about the content, style, policy recommendations, and general usefulness of this book; yet, we think it deserves careful attention and raises important questions about the proper use of analytical methods in agricultural planning and development.

Its contents are standard and straightforward. The authors take a well-known methodology (linear programming) and apply it to a common problem (industrial investment) in a general development context (agricultural and planning and fertilizer use). The authors focus on a particular example (Egyptian fertilizer production) of interest to the World Bank. In addition to the theoretical equations of a linear model, their book contains many tabulations and interpretations useful to both planners and policymakers unfamiliar with linear programming.

The authors carefully document their equations and assumptions. In the first part, they present a clear and nontechnical introduction to the chemical fertilizer industry and to their methodology. Separate chapters describe the production processes of phosphatic, potassic, nitrogenous, and multinutrient fertilizers; their investment planning model; and associated linear programming tableaux.

In the second part, they apply their methodology to the Egyptian fertilizer sector. They focus on exogenous factors, such as demand, imports, and prices; they describe their 1975 model and give two solutions—a base solution and one which includes interplant shipments under a full-capacity policy.

In the final chapters, the authors extend their 1975 model to a medium-term, dynamic planning model of the Egyptian fertilizer sector. They use their base solution to derive policy conclusions concerning plant development in the areas of the Suez Canal and Aswan Dam. An appendix lists the computer input and reference data for the Egyptian model.

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The book has several possible audiences. It will appeal to economists and agriculturalists looking for a practical introduction to linear programing, as well as to operations researchers and applied mathematicians looking for new applications for this technique. The writing, while somewhat dry and pedantic, is succinct. We found the index, appendixes, and copious tables of great assistance.

Nonetheless, we found the book incomplete in many respects and difficult to categorize. Although it is presented as a textbook, we were forced to conclude that it is essentially a consultant's report. We found no bibliography, no historical background, and no consideration of alternative methods. It presents no clear rationale for considering the fertilizer investment problems, the particular example of the Egyptian sector, or the choice of solution. We assume the World Bank had an interest in the project, although its purposes are nowhere referred to in the text. Unlike many similar development or planning studies, the report never questions methods, choices, and assumptions.

And yet, it is precisely the interrelationships of conflicting objectives and the necessity of carefully choosing a methodology in full knowledge of its flaws and premises that constitute the real work of development economics and planning. Although the book includes a short introduction to the Egyptian fertilizer industry in 1975, it describes neither the role of the Egyptians—none of whom is even mentioned—nor the model's ultimate value, if any, to Egypt or to the World Bank.

This study has limitations from our analytical viewpoint, even if one accepts the appropriateness of a linear programing process model of the fertilizer industry. As a consultant's report, the work is flawed by its apparent blindness to the larger policy context and other economic constraints. Fo. example, the objective function of the model is essentially to minimize plant nutrient costs. But, is it desirable for Egypt to be totally self-sufficient in fertilizer (as is implicitly assumed)? Can one legitimately advocate the further construction or expansion of fertilizer plants when other projects compete for scarce capital resources? The book does not address the needs of planners in capital-constrained countries such as Egypt who must choose among projects with positive benefit/cost ratios.

Furthermore, we find the author's assumptions and modeling work suffers from a similar myopia. The authors seem to suggest that all planning decisions can be made from linear programing. However, there are many useful alternatives to

linear programming, most of which can be explained in a straightforward manner; the literature in planning and development is filled with such methods and decisions criteria. More important, the authors need to explain the economic assumptions and the limitations of linear programming to readers, especially those who are planners and policymakers with little formal training in agricultural economics or operations research.

We question whether several of the authors' policy conclusions are fully supported by their model. For example, they conclude that 5 million Egyptian pounds might be saved if farmers switched from traditional fertilizer to urea, and they suggest that an expenditure up to this amount should be made on education extension and demonstration plots. However, this recommendation implicitly assumes, contrary to known development experience, that all farmers have a similar profitmaking incentive for using urea. The authors also recommend the addition of ammonia capacity in the Suez, rather than its production in Helwan. This conclusion assumes a stable transportation network with current unit costs and disregards their earlier demonstration of the model's sensitivity to changes in the transportation structure. It would have been relatively easy to conduct a parametric analysis which would considerably strengthen their advocacy of such a major decision.

How can these studies be used? We believe this text would provide excellent supplementary reading or be useful as a casebook for any extensive course in agricultural development. It is a far more accessible and representative example of World Bank modeling activity than many larger projects, and it might stimulate thoughtful classroom discussions. It could also serve as a "cookbook" for planners interested in applying linear programming. Here we should mention one of the well-known strengths of linear programming work—its strong focus on data needs, an element which the book handles well. Finally, the chapters on fertilizer technology and basic linear modeling are extremely well written.

In Earlier Issues

Only through careful study of past changes can [agricultural economists] understand the relative significance of the forces that brought them about and only with such understanding can they do a reasonably good job of forecasting future changes.

Marguerite C. Burk and Martin J. Gerra
Vol. 6, No. 2, Apr. 1954, p. 33

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